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Westcott's Plant Disease Handbook

R. Kenneth Horst

7th Edition

Springer

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Seventh Edition

Revised by R. Kenneth Horst

With 90 figures and 2 tables

Springer

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This 7th Edition of the Plant Disease handbook is dedicated to the mentoring experiences I have had the pleasure of experiencing starting with Pleasant View Grade School, North Lawrence, OH, to Massillon Washington High School, Massillon, OH, to Ohio University, Athens, OH, to The Ohio State University, Columbus, OH, to Yoder Bros., Inc., Barberton, OH, to Cornell University, Ithaca, NY (Professor, Department of Plant Pathology). Although I felt in those early years that I was doing all the learning, I soon found that mentoring was a two-way phenomenon. Not only was I mentoring my students at Cornell University, but I found I was learning from them as well.

I was stimulated to reflect on this by my two youngest grandchildren, Madeline Turner and Trevor Horst to whom I dedicate this 7th Edition as well as the students who taught me while I was teaching them. Madeline initiated this process when I asked her what she was learning in kindergarten. When she listed all that she was learning. I indicated she was really getting smart and that maybe Grampy should go to kindergarten so that he could get smart. She said "No Grampy you can't" and I asked her "why not" and she aid "Because you're no kid anymore". What a great answer and also very profound since she was really telling me I needed to continue moving beyond being a kid in my learning process.

Students (Masters, Doctoral and Post-Doctoral Students) I have mentored and from whom I have also learned much.

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Sek-Man Wong

Preface to the Seventh Edition

It was a compliment to me to be asked to prepare the fourth edition of *Westcott's Plant Disease Handbook*, and the decision to accept the responsibility for the fourth edition, the fifth edition, the sixth edition, and now the seventh edition was not taken lightly. The task has been a formidable one. I have always had great respect professionally for Dr. Cynthia Westcott. That respect has grown considerably with the completion of the four editions. I now fully realize the tremendous amount of effort expended by Dr. Westcott in developing the *Handbook*. A book such as this is never finished, since one is never sure that everything has been included that should be. In the 6 years since the sixth edition there were more than 600 new reports of diseases on plants. I would quote and endorse the words of Dr. Westcott in her preface to the first edition: "It is easy enough to start a book on plant disease. It is impossible to finish it . . . " Dr. Cynthia Westcott passed away March 22, 1983.

This revision of the *Handbook* retains the same general format contained in the previous editions. The chemicals and pesticides regulations have been updated; major taxonomic changes have been made in the bacteria, fungi, nematodes and viruses; the changing picture in diseases caused by viruses and/or viruslike agents have been described. New host plants have been added, and many recently reported diseases as well as previously known diseases listed now on new hosts have been included in the Handbook. In addition photographs have been retained from the sixth edition as well as the color photograph section. For the photography work I am grateful for the help and expertise of Kent E. Loeffler. I also had access to the Cornell Plant Pathology Herbarium, which contains a wealth of photographic work

on plant diseases that has been supplied by numerous scientists over many years.

This book should be useful to gardeners, master gardeners, botanical gardens, landscape architects, florists, nurserymen, seed and fungicide dealers, pesticide applicators, arborists, cooperative extension agents and specialists, plant pathologists, diagnostic laboratories and consultants. The book should also be a useful reference book for plant pathology classrooms and in some cases used as a textbook.

February 2008 R. Kenneth Horst

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I am indebted to many people for advice and suggestions for the 7th edition. The reviewers acquired by Kluwer Academic Publisher to review the 5th Edition and to advise on significance of a 6th Edition provided many helpful suggestions which were used in the 7th Edition. Moreover, a few individuals who were particularly helpful in my tasks of updating and putting together the revision for the 7th Edition into an appropriate format were J. Esnard, K. Hodge, S. J. Ingalls, K. Loeffler, C. Palmer, K. Snover, R. E. Stall, B. Szyndel and M. S. Szyndel. Finally, I recognize and appreciate the professional and efficient job of typing the manuscript by Margaret Haus and her dedicated efforts in aiding me in proofreading, which was a major task with the increasing size of the book and the changing scientific names of the pathogenic organisms.

Contents

How to Use This Book 1

Introduction 3

1 Garden Chemicals and Their Application 11

Fungicides 16

Bactericides 26

Nematicides 28

Virocides 29

Applying the Chemicals 30

Spraying vs Dusting 36

Mixing the Chemicals 37

All-Purpose Sprays and Dusts 39

Integrated Pest Management 40

2 Classification of Plant Pathogens 43

Fungi 46

Bacteria 64

Viruses, Viroids, Phytoplasmas 68

Nematodes 77

3 Plant Diseases and Their Pathogens 81

Anthracnose 83
Bacterial Diseases 98
Black Knot 134
Blackleg 137
Black Mildew 139
Blackspot 144
Blights 150
Blotch Diseases 218
Broomrapes 223
Cankers and Diebacks 224
Club Root 268
Damping-Off 270
Dodder 272
Downy Mildews 275
Fairy Rings 284
Fruit Spots 286
Galls 289
Leaf Blister and Leaf Curl Diseases 295
Leaf Scorch 298
Leaf Spots 302
Lichens 366
Mistletoe 367
Molds 372
Needle Casts 375
Nematodes 382
Nonparasitic Diseases 413
Powdery Mildews 439
Rots 455

Rusts 534
Scab 571
Scurf 579
Slime Molds 581
Smuts 582
Snowmold 592
Sooty Mold 594
Spot Anthracnose 596
Virus, Viroid, Phytoplasma – Pathogens and Diseases 602
White Rusts 679
Wilt Diseases 681
Witchweed 698

4 Host Plants and Their Diseases 699

Host Plants 702

Land-Grant Institutions and Agricultural Experiment Stations in the United States 1147
Glossary 1151
Selected Bibliography 1163
Index 1177

How to Use This Book

This is a reference manual. You will certainly not read it through from cover to cover, but I hope you will read the first and last section of ▶ Chap. 1 on garden chemicals. The chemicals themselves are listed in alphabetical order, by common names where possible, by trade names where these are used in lieu of approved common names. A few materials still in the experimental stage but very promising are included. A few uses are suggested, but many more, with correct dosages, will be found on the labels or in recent publications.

▶ Chapter 2, on the classification of plant pathogens, can be taken or not as desired. It provides a mycological, bacteriological, nematological and virological background for students and a review for professional workers. The bibliography gives some of the taxonomic references consulted in preparing this very condensed treatment.

The rest of the book is in two main sections. ▶ Chapter 3 describes specific diseases and gives remedies when known. The diseases are grouped according to their common names into forty types treated in alphabetical order.

▶ Chapter 4 gives 1309 host plants in alphabetical order, from Abelia to Zoysia, according to common names except where the Latin name may mean less confusion. Under the hosts the disease are sorted out according to types, given in small capitals, and you can quickly thumb back to the corresponding section, Anthracnose, Blight, Wilt, etc., in ▶ Chap. 3 by means of the running head at the top of each page.

The book works like a dictionary. In both the disease and host section the Latin name of the pathogen causing the disease is given in **boldface** type. The individual diseases in the host section are listed in alphabetical order according to the common name of the diseases.

You may be able to find the information you are seeking directly from the index, which includes common and Latin names of hosts plants, Latin names of pathogens and common names of the diseases described in ►Chap. 3. More than 4000 diseases are included in that chapter and some additional pathogens are listed under Host Plants without a corresponding description of disease.

Website addresses of state universities and agricultural experiment stations, which are sources of help for every gardener, are given following ►Chap. 4.

The very best way to use this book is to take it in small doses as needed. Do not let the hundreds of diseases you will never meet worry you too much. And remember that most plants survive, despite their troubles!

Introduction

The chief hazard any garden plant has to endure is its owner or gardener. Moreover, many plants will suffer undue hardship from the publication of this handbook. It is human nature to read symptoms of an ailment and immediately assume it is your own affliction. Jumping to conclusions is as dangerous to plants as to humans. A sore throat does not necessarily mean diphtheria. Only a trained physician can diagnose probable diphtheria, and for positive identification a laboratory culture is necessary.

A spotted or yellowed rose leaf does not necessarily mean rose blackspot. Mite injury, spray injury, or reaction to weather conditions may also cause spotted or yellow rose leaves; yet gardeners blithely continue increasing the spray dosage, confident that more and stronger chemicals will control the "disease" and seldom notice they are nearly killing the patient in the process.

A browning azalea flower does not necessarily mean the dreaded petal blight. Some years ago a Westcott article on possible azalea troubles appeared in print about the time azalea blooms in a Northern region were turning brown from a combination of unusual weather conditions. Some gardeners immediately assumed the worst, thought that the southern blight had arrived in the North, and started spraying. The poor plants, suffering from drought and a heat wave, suffered additional injury from the additional stress of sprays.

All chemicals used as sprays or dusts are injurious to plants under some conditions, the injury varying with the chemical and the dosage, with the species and even the variety of plant, with temperature, soil moisture, and many other factors. Plants suffering from drought are commonly injured by sprays.

So please, don't jump to conclusions. Don't do anything in a hurry because the plants are getting sick fast and there is no time for a proper diagnosis.

Don't rush to the seed store to buy some chemical you vaguely remember reading about. Relax! You have all the time in the world for proper identification, since, by the time the disease is serious enough for you to notice, it is probably too late for protective spraying this season anyway.

Browning of an azalea flower means nothing as a diagnostic symptom. It could just as well come from frost, heat, or old age as from a pathogen. If the flowers are limp and collapsed with a *slimy* feel, these are good symptoms, but signs of the fungus are needed as well. Thin, slightly curved black bodies (sclerotia) formed at the base of petals are distinctive, but even more conclusive are spores taken from the inside of the petals and examined under a microscope. If these are 1-celled, with a little boxlike appendage, then you may reasonably conclude that you have the true azalea petal blight.

This is a book of garden diseases, but it is not expected that anyone, amateur or professional, can read a brief description, look at an unfamiliar disease in the garden, and make a very reliable diagnosis. I certainly cannot, and after compiling this tome I am less likely to try than ever before. I have written "water-soaked" or "reddish brown" too many hundreds of times for different diseases to make such symptoms seem very distinctive.

However, if you are a gardener, you can narrow the field down considerably by consulting ►Chap. 4, where host plants are listed in alphabetical order, and under each the type of disease – Blight, Canker, Leaf Spot, etc. – and then the organisms causing these diseases by their scientific names and the states where they have been reported. Eliminating the types of disease that are obviously different from yours and eliminating diseases that are reported only on the West Coast when you live in New York, you may find only two or three possibilities to look up in ►Chap. 3, which lists, under the different disease groups, the pathogens in alphabetical order, followed by a discussion of each disease. In situations where pathogen names have been changed due to critical investigations of spore formation and development, the original name is listed in alphabetical order followed by "see new name". Under the new name in parenthesis "formerly old name" is indicated.

Don't let all the scientific names worry you. It is the only way to make this a quick and easy reference, for there are very few common names of plant diseases that can be used without confusion. It works just like the telephone book. While thumbing your way down to Smith, John, you do not worry about spelling Smiecinski, C., which you pass on the way.

If you are a quasi-professional, with little or no formal mycology but trying to keep abreast of a flood of miscellaneous specimens, there is a brief review

for you of the salient microscopic characteristics of each genus, together with its classification. This is in small type and may be readily passed over by those interested solely in macroscopic characteristics.

What is Plant Disease?

There are many definitions of plant disease, the simplest being any deviation from the normal. The concept of the late professor H. H. Whetzel, a great teacher of plant pathology who influenced many students including Dr. Cynthia Westcott, is valid and appropriate even today. "Disease in plants is an injurious physiological process, caused by the *continued* irritation of a primary causal factor, exhibited through abnormal cellular activity and expressed in characteristic pathological conditions called symptoms." The causal factor may be a living organism or an environmental condition. Injury differs from disease in being due to the *transient* irritation of a causal factor, as the wound of an insect, sudden freezing or burning, application of a poison.

Plant diseases may be *necrotic*, with dying or death of cells, tissues, or organs; *hypoplastic*, resulting in dwarfing or stunting; or *hyperplastic*, with an overgrowth of plant tissue, as in crown gall or club root.

Plant Diseases are not New

All species of plants, wild and cultivated, are subject to disease. Fossil remains suggest that plant diseases were present on earth before man himself. Certainly man has been punished by them ever since the garden of Eden. "I smote you with blasting and with mildew and hail in all the labors of your hands yet ye turned not to me, saith the Lord" (Haggai 2:17).

Man's attempts at controlling plant disease go back at least to 700 B. C. when the Romans instituted the Robigalia to propitiate the rust gods with prayer and sacrifice. About 470 B. C. Pliny reported that amurca of olives should be sprinkled on plants to prevent attacks of blight, this being our earliest known reference to a fungicide, although Homer, 1000 B. C., wrote of "pest-averting sulfur."

In 1660 at Rouen, France, a law was passed calling for eradication of the barberry as a means of fighting wheat rust, two centuries before anyone knew the true nature of rust or how barberry affected wheat.

In the latter part of the eighteenth century the Englishman Forsyth discoursed on tree surgery and treatment of wounds and cankers. His seemingly fantastic

recommendation of a paste of cow dung to promote healing of tree wounds has modern corroboration in research showing that urea speeds up healing of such wounds.

Much of our progress in dealing with plant disease has followed spectacular catastrophes. Modern plant pathology had its start with the blight that swept the potato fields of Europe in 1844 and 1845, resulting in the Irish famine. This lesson in the importance of plant disease to the economic welfare of mankind marked the beginning of public support for investigations into the cause of disease. Two men, both German, laid the firm foundations of our present knowledge. Mycologist Anton de Bary, 1867 to 1888, first proved beyond doubt that fungi associated with plant diseases were pathogenic, while Julius Kuhn, farmer with a doctor's degree in science, first showed the relation between science and practice in the problems of plant disease control. His textbook on *Diseases of Cultivated Plants*, published in 1858, is still useful.

The accidental discovery of bordeaux mixture in France in 1882 marks the beginning of protective spraying for disease control, but the use of drugs goes back to 1824, when sulfur was recommended as an eradicant for powdery mildew. The development of synthetic organic fungicides was sparked by World War II, partly as a result of a search for chemicals to mildew-proof fabrics used by the armed forces. Antibiotics for plant disease control followed their use in medical practice, with a great deal of research in this field since 1949.

Since the establishment of the Environmental Protection Agency in 1972 there has been increased concern on the use of toxic chemicals for controlling plant disease. Moreover, this concern has generated renewed interest in integrated pest management (IPM) and biological control strategies in the 1980's. IPM utilizes all available pertinent information regarding the crop or plant, its pathogens, the environmental conditions expected to prevail, locality, availability of materials, and costs in developing the control program. Biological control is the total or partial destruction of pathogen populations by other organisms. This phenomenon occurs routinely in nature. There are several diseases in which the pathogen cannot develop because the soil, called suppressive soils, contain microorganisms antagonistic to the pathogen, or because the plant that is attacked has been naturally inoculated before or after the pathogen attack, with antagonistic microorganisms. Even higher plants may reduce the amount of pathogen inoculum by trapping available pathogens (trap plants) or by releasing substances toxic to the pathogen into

the soil. Although biological antagonisms are subject to numerous ecological limitations it can be expected to become an important part of control measures employed against many more diseases in future years.

Plant Pathology in the United States

Organized plant pathology in the United States started in 1885 with a section of Mycology in the U.S. Department of Agriculture. In 1904 the start of the great epiphytotic of chestnut blight, which was to wipe out our native trees, stimulated more public interest and support for plant pathology. In 1907 the first university Department of Plant Pathology was established at Cornell University.

The United States Quarantine Act of 1912 officially recognized the possibility of introducing pests and diseases on imported plants, after low-priced nursery seedlings from Europe had brought in the white pine blister rust. This was our first attempt at control by exclusion.

In 1917, during World War I, the Plant Disease Survey was organized as an office of the Bureau of Plant Industry "to collect information on plant diseases in the United States, covering such topics as prevalence, geographical distribution, severity, etc, and to make this information immediately available to all persons interested, especially those concerned with disease control." During World War II the Plant Disease Survey was in charge of the emergency project "to protect the country's food, feed, fiber and oil supplies by ensuring immediate detection of enemy attempts at crop destruction through the use of plant diseases and providing production specialists and extension workers with prompt and accurate information regarding outbreaks of plant diseases whether introduced inadvertently or by design while still in incipient stages." As a by-product of these wartime surveys we accumulated a good deal of evidence on the prevalence of new and established diseases across the country, in home gardens as well as on farms.

In 1946, a century after *Phytophthora infestans* had made history with the potato blight, a strain of the same fungus started an unprecedented epiphytotic of tomato blight. This disaster led to the forecasting service warning dealers and growers when certain diseases are imminent.

The Plant Disease Survey has now become the Epidemiology Investigations Section of the Agricultural Research Service of the U.S. Department of Agriculture. The Agricultural Research Service became a part of the Science and Education Administration in 1978. It issues a monthly bulletin, *The*

Plant Disease Reporter, based on reports from qualified volunteer collaborators all over the country. The American Phytopathological Society assumed the responsibility for publishing this journal in 1980 and the journal was renamed *Plant Disease*. Much of the material in this handbook is taken from these reports.

Principles of Control

Control of a plant disease means reduction in the amount of damage caused. Our present annual toll from disease is nearly four billion dollars. Perfect control is rare, but profitable control, when the increased yield more than covers the cost of chemicals and labor, is quite possible. Commercial growers now average a return of four dollars for each dollar so invested. Keeping home plantings ornamental yields a large return in satisfaction and increased property value.

The five fundamental principles of control are exclusion, eradication, protection, resistance, and therapy.

1. *Exclusion* means preventing the entrance and establishment of pathogens in uninfested gardens, states, or countries. For home gardeners it means using certified seed or plants, sorting bulbs before planting, discarding any that are doubtful, possibly treating seeds or tubers or corms before they are planted, and, most especially, refusing obviously diseased specimens from nurseryman or dealer. For states and countries, exclusion means quarantines, prohibition by law. Sometimes restricted entry of nursery stock is allowed, the plants to be grown in isolation and inspected for one or two years before distribution is permitted.
2. *Eradication* means the elimination of a pathogen once it has become established on a plant or in a garden. It can be accomplished by *removal* of diseased specimens, or parts, as in roguing to control virus diseases or cutting off cankered tree limbs; by *cultivating* to keep down weed hosts and deep ploughing or spading to bury diseased plant debris; by *rotation* of susceptible with nonsusceptible crops to starve out the pathogen; and by *disinfection*, usually by chemicals, sometimes by heat treatment. Spraying or dusting foliage with sulfur after mildew mycelium is present is eradication, and so is treating the soil with chloropicrin to kill nematodes and fungi.
3. *Protection* is the interposition of some protective barrier between the susceptible part of the suscept or host and the pathogen. In most instances

this is a protective spray or dust applied to the plant in advance of the arrival of the fungus spore; sometimes it means killing insects or other inoculating agents; sometimes it means the erection of a windbreak or other mechanical barrier.

►Chapter 1 gives an alphabetical list of chemicals used in present-day protective spraying and dusting, along with eradicant chemicals, and includes notes on compatibility and possibilities of injury. It is here that home gardeners, sometimes commercial growers, can do their plants irreparable harm instead of the good they intend. Spraying is never to be undertaken lightly or thoughtlessly. Stop and think! Read all of the fine print on the label; be sure of your dosage and the safety of that particular chemical on the plant you want to protect, to say nothing of precautions necessary for your own safety.

4. *Resistance* is control by the development of resistant varieties. Resistant varieties are as old as time. Nature has always eliminated the unfit, but since about 1890 man has been speeding up the process by deliberately breeding, selecting, and propagating plants resistant to the more important diseases. Resistant ornamental plants have lagged behind food plants, but we do have wilt-resistant asters, rust-resistant snapdragons, wilt-resistant mimosas. Here is the ideal way for home gardeners to control their plant diseases – in the winter when the seed order and the nursery list is made out – so easy, and so safe!
5. *Therapy* is control by inoculating or treating the plant with something that will inactivate the pathogen. Chemotherapy is the use of chemicals to inactivate the pathogen, whereas heat is sometimes used to inactivate or inhibit virus development in infected plant tissues so that newly developing tissue may be obtained which is free of the pathogen. The use of this procedure is discussed in ►Chap. 2.

Chapter 1
Garden Chemicals and Their Application

A **fungicide** is a substance that destroys or inhibits the growth of fungi. It may be an **eradicant**, applied to a plant, plant part, or the environment as a curative treatment to destroy fungi established within a given area or plant; or preferably it may be a **protectant**, applied to protect a plant or plant part from infection by killing, or inhibiting the development of, fungal spores of mycelium that may arrive at the infection court. A **bactericide** is a substance that destroys or inhibits bacteria and nematicide for nematodes. Among the more recent bactericides are antibiotics, products of other living organisms. They also have value against certain fungi. There are few **virocides**, which are toxic or poisonous to viruses.

A **pesticide** is any chemical that is used to kill pests, especially insects and rodents.

An **insecticide** is an agent used to kill insects.

A **disinfectant** is an agent that frees a plant or plant part from infection by destroying the pathogen established within it. A disinfectant kills or inactivates organisms present on the surface of the plant or plant part or in the immediate environment. Chemicals for seed treatment can be either eradicants or protectants, but most of them are disinfestants, in that they kill organisms on the surface of the seed rather than those within. In common usage, however, they are called disinfectants.

A **nematicide** is, of course, a chemical that kills nematodes in the soil or in the plant. Most nematicides are **fumigants**, chemical toxicants that act in volatile form.

Not so long ago the chemicals on the garden medicine shelf consisted of copper and sulfur for protectants, lime sulfur as an eradicant, mercuric chloride as a disinfectant, and formalin and carbon bisulfide a fumigants. You some-

times got plant injury; you did not always get the best possible control, but at least you did not have to be an organic chemist. Now we have the following classes of fungicides:

Inorganic	Organic
Sulfur	Dithiocarbamates
Copper	Thiazoles
Salts	Triazines
	Substituted aromatics
	Dicarboximides
	Dinitrophenols
	Quinones
	Antibiotics
	Organotins
	Aliphatic nitrogens
	Benzimidazoles
	Sterol Inhibitors
	Strobilurins

The search for new fungicides goes on, with hundreds of synthetic organic compounds being screened each year. This screening is often a cooperative venture between manufacturers, state experiment stations, and the U.S. Department of Agriculture. After safety precautions for the operator and the environment, and the effectiveness of a compound for certain diseases have been determined, the chief question is whether the material is **phytotoxic**, that is, injurious to plants, at concentrations required for control. Phytotoxicity is an elusive factor, not to be pinned down in a few tests. It varies not only with the kind of plant but with the particular variety, the amount of moisture in the soil when the spray is applied, the temperature, whether or not the application is followed by rain or high humidity, the section of the country, and the compatibility of the chemical with spreaders or wetting agents, as well as with other fungicides or insecticides. Coordinated tests with new materials in many different states are extremely valuable. Some compounds give rather uniform results over the country; others vary widely with climatic conditions.

The 1947 Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) provides that all fungicides must be registered with the U.S. Department of Agri-

culture before being marketed. Materials highly toxic to humans must be prominently marked, instructions given for avoiding injury to plants or animals, the toxicant chemical named, and the percentage of active and inactive ingredients given. All labels submitted for registration must be accompanied by proof that the claims for performance are valid.

In 1954, Public Law 518, known as the Miller Bill, was passed, providing for tolerances. A tolerance is the legal limit of a poisonous residue, expressed in parts per million (ppm), that may remain on an edible product at the time it is distributed for consumption. In 1958, The Food Additives Amendment was passed, which also controls pesticides residues in processed foods. It included the Delaney clause, which states that any chemical found to be a carcinogen in laboratory animals may not appear in a human food, a zero tolerance. In 1959, the FIFRA was amended to include nematicides, plant growth regulators, defoliants, and desiccants as pesticides. Since that time, poisons and repellents used against all classes of animals (from invertebrates to mammals) have been brought into the approval process.

FIFRA was further amended in 1972 as the Federal Environmental Pesticide Control Act (FEPCA), making violations by growers, applicators, or dealers subject to heavy fines and/or imprisonment. All pesticides had been classified into either general-use or restricted-use categories by October 1977, with anyone applying restricted pesticides required to be state-certified. Pesticide manufacturing plants are to be registered and government-inspected. All pesticide products must be registered whether shipped in interstate or intrastate commerce. Other provisions are of various degrees of importance to concerned persons or companies.

Additional modifications were made in FIFRA in 1989. The modifications specifically will (1) accelerate re-registration of older pesticides (those registered prior to November 1984) and impose fees on chemical manufacturers for re-registration; (2) essentially eliminate indemnification payments to those holding inventories of suspended or canceled pesticides, except farmers and certain end users; and (3) shift part of the burden for storage and disposal of banned pesticides from the government to the manufacturer. The 1989 FIFRA also empowers the Environmental Protection Agency (EPA) to change regulations on how applicators handle, rinse, and dispose of pesticide containers. The Worker Protection Standard (WPS), passed in 1992, required labels to carry re-entry intervals (REI) and personal protection equipment for certain end-uses. Labels having both WPS and non-WPS uses are required to have recommendation for PPE and REI for both categories.

In 1996, the Food Quality Protection Act (FQPA) was passed, requiring a 10-year review process of all currently registered pesticides based on a risk cap of aggregate exposure, in other words all possible ways people, particularly children, can come into contact with pesticides whether through residues on food or backyard applications. Part of FQPA determined that an acceptable level of risk is a reasonable certainty of no harm, essentially eliminating the Delaney Clause from 1958. The FQPA also provided for accelerated registrations of safer pesticides, such as biological control organisms or active ingredients with the potential for minimal environmental impact.

The federal government considers these to be minimum pesticide regulations. Any state may choose to establish more rigid pesticide regulations within its boundaries than those legislated by the federal government, and some have done so. Some states require notification to be posted prior to commercial pesticide application including chemicals used. Thus, pesticide applicators must be familiar with individual state pesticide regulations as well as federal pesticide regulations.

Consumers, therefore, are well protected against fraud, but they must be willing to read the fine print on labels if they are to choose intelligently from the bewildering array of proprietary compounds on dealers' shelves. In the following pages there are lists of available products, cross-referenced by product name and the common name of active ingredients. In many cases, several product names may exist for the same active ingredient; those readily available to consumers may not be listed so pay particular attention to the name of the active ingredient present on the available products. Consumers must also read the fine print and follow directions exactly if their homegrown vegetables are to be as safe for consumption as those from commercial growers who have to comply with the law in the matter of residues.

Even if you follow exactly the directions for dosage given on the label, you may have some plant injury under your particular combination of soil, weather, and kinds of plants. Keep a notebook. Put down the date you sprayed, the dosage used, the approximate temperature and humidity, whether it was cloudy or sunny, in a period of drought or prolonged wet weather. Go around later and check for burning; for leaf spotting and defoliation from the spray or from failure to control the disease; for leaf curling or stunting; for too much unsightly residue. Note which varieties can take the spray and which cannot.

The following alphabetical list includes chemicals now commercially available, a few that are rather outmoded but still found in textbooks, a few that

were marketed in the past but have now been discontinued, and a few that will probably be marketed before this text is published. By that time there will be many more that should have been included, for the search for better chemicals is unending. There will also be more that will be discontinued. The list presented herein must be considered only as a guide. Exclusive reliance must be placed on directions and information supplied by the manufacturer or by agricultural specialists, agents, or advisors. **Be sure to read the label**. Because so many of the new compounds have long, complex chemical names, they have been given short common names by the American Standards Association. Such common names are listed first in the following listing. Frequently, however, the trade name is used as a common name; trade names are listed in parenthesis following the common names. The Crop Protection Handbook, which is published each year by Meister Publishing Co., 37841 Euclid Ave., Willoughby, OH, 44094, gives an up-to-date listing of pesticides. Vance Publishing publishes the Turf and Ornamental Reference and the Crop Protection Reference (Greenbook).

As always, read and follow label directions carefully. If unsure whether a listed product is registered in your area, contact local, state, and federal authorities.

In the following lists, the common chemical name is given first, in bold, followed by trade names available for professional growers of agricultural, turf and ornamental crops and products available for consumers. Then there is a brief description of target pathogens.

FUNGICIDES

Azoxystrobin

Abound, Amistar, Bankit, Heritag, Ortiva, Priori, Quadris
Systemic fungicide for control of foliar and soil borne diseases.

Bacillus subtilis

Serenade, Subtilex, Taego, Companion, Kodiak
Used as a seed treatment to suppress *Rhizoctonia* and *Fusarium* diseases.

Benalaxyl

Galben, Tairel
Systemic fungicide.

Bitertanol

Bacseal, Baycor, Baycoral, Baymat, Zaron
Fungicide.

Bordeaux Mixture

Comac

Bordeaux mixture is made in varying concentrations. The most usual formula is 8-8-100 (often stated as 4-4-50), which means 8 pounds copper sulfate, 8 pounds hydrated lime to 100 gallons of water. Stock solutions are made up for each chemical (1 pound per gallon of water), the lime solution placed first in the sprayer, diluted to nearly the full amount, and the copper sulfate solution added. Or, for power sprayers, finely divided copper sulfate can be washed through the strainer into the spray tank, and when the tank is two-thirds full the weighed amount of hydrated lime can also be washed through the strainer while the agitator is running. Casein or other spreader is added toward the end. Phytotoxicity comes from both the lime and the copper. Plants are often stunted, with yield reduced; fruit-setting of tomatoes may be delayed. Bordeaux is not safe on peaches during the growing season, may burn and russet applies (both foliage and fruits), may cause red spot-

ting, yellowing, and dropping of rose leaves (often confused with blackspot by amateur and sometimes professional gardeners), and may cause defoliation of Japanese plums. Injury is most prominent early in the season when temperature is below 50°F and in dull, cloudy weather when light rain or high humidity prevents rapid drying of the spray. Late summer use of bordeaux is credited with making some plants more susceptible to early fall frosts. For ornamentals, a 4-4-100 mixture is usually strong enough and can be made in small amounts by dissolving 2 ounces of copper sulfate in 1 gallon of water, 2 ounces of hydrated lime in 2 gallons of water, pouring the copper sulfate solution into the lime water, and straining into the spray tank through fine cheesecloth. For some plants, such as stone fruits, the proportion of lime is increased; for others, such as azaleas, a low-lime bordeaux is used. Once the two solutions have been mixed, the preparation must be used immediately. Fresh lime is essential, not some left over from a previous season. Somewhat less effective than homemade bordeaux but easier for the home gardener are the various powders and pastes available under trade names; to these add only water at the time of use.

Bupirimate

Nimrod
Systemic fungicide.

Burgundy Mix

A soda bordeaux formerly used, prepared with washing soda instead of lime.

Burkholderia Cepacia

Fungicide, nematicide.

Captan

Captan 30 DD, Captan 400
Protectant, eradicant fungicide.

Carbendazim

Bavistin, Decrosol
Systemic fungicide.

Carbon Disulfide

Soil fumigant.

Carboxin

Vitavax
Fungicide, seed protectant.

Chloranil

Foliar fungicide and seed treatment.

Chloroneb

Terraneb, N-Flow D, Proturf
Fungicide.

Chloropicrin

Chloro-O-Pic
Soil fumigant.

Chlorothalonil

Bravo, Bravo Ultrex, Bravo Weatherstik
Fungicide.

Copper Acetate

First developed in 1889; became the first factory made basic copper fungicide.

Copper Ammonium Carbonate

Copper-Count-N
Bactericide, Fungicide.

Copper Carbonate

Foliar fungicide, Seed treatments.

Copper Compounds

More stable than bordeaux mix, less phytotoxic, easier to use, and with less objectionable residue. Copper sprays control many blights, leaf spots, downy and powdery mildews. They are incompatible with lime sulfur, questionable with cryolite, benxene hexachloride, tetraethyl pyrophosphate, organic mercuries, and thiocarbamates. They may injure plants in cool, cloudy or moist weather. Injury to apple and rose foliage varies from reddish spots to yellowing and defoliation.

Copper Hydroxide

KOP Hydroxide
Fungicide, bactericide.

Copper Oxide

Chem Copp, Cuprocop, Cuprox, Caocobre, Copper Sandoz
Protective fungicide.

Copper Oxychloride

KOP Oxy-85, Recop, Coprantol, Cupramar, Cupravit
Protective fungicide.

Copper Sulfate

Tribasic (Flurane, Idrorame, King, Diachum)
Fungicide.

Cufraneb

Fungicide. Miticide, Seed Dressing.

Cycloheximide

Antibiotic fungicide from *Streptomyces griseus*, the first antibiotic introduced (1949) for control of plant disease.

Cymoxanil

Curzate
Fungicide.

Cyproconazole

Alto, Atemi, Sentinel
Systemic and eradicative fungicide.

Cyprodinil

Chieftain, Chorus, Unix, Vangard
Fungicide, seed treatment.

Dazomet

Basimid
Soil fumigant.

Dichlofluanid

Elvaron, Euparen
Fungicide.

Dicloran

Allisan, Botran, Clortran
Fungicide.

Difenoconazole

Bardos, Bogard, Dividend, Geyser, Score, Sico
Systemic fungicide.

Dimethirimol

Milcurb
Systemic fungicide.

Dimethomorph

Acrobat, Forum
Oomycete fungicide.

Diniconazole

Mitazole
Systemic fungicide.

Dithianon

Delan
Fungicide.

Dodemorph Acetate

Meltatox
Fungicide.

Edifenphos

Hinosan
Fungicide.

Epoxiconazole

Opal, Opus
Systemic fungicide.

Etridiazole

Terrazole, Koban, Truban
Soil fungicide.

Fenaminosulf

Protects germinating seeds and seedlings in corn, beans, peas, spinach, cucumbers, and ornamentals.

Fenarimol

Used for powdery mildew and rust on ornamentals, turf, and tree crops.

Fenbuconazole

Enable, Govern, Indar
Systemic fungicide.

Fenpiclonil

Beret, Electer, Gambit

Fenpropidin

Mildin, Patrol, Sorilan, Tern
Systemic fungicide.

Fenpropimorph

Corbel
Systemic fungicide.

Ferbam

Ferman Granuflo
Fungicide.

Filipin

Antibiotic. Fungicide for seed-rot fungi.

Fluazinam

Omega
Fungicide, Miticide.

Fludioxonil

Celest, Geoxe, Maxim, Medallion, Saphire, Savior, Scholar
Contact fungicide.

Flusilazole

Fungicide.

Flutolanil

Folistar, Moncut, Prostar
Systemic fungicide.

Folpet

Folpet
Protective fungicide.

Fosetyl-Aluminum

Aliette, Chipco
Systemic fungicide, bactericide.

Hexaconazole

Anvil, Planete Aster
Fungicide.

Hydrated Lime and Copper Sulfate

Bordeaux Mix
Prepared from copper sulfate and lime to form a membranous coating over plant parts, the first protective spray and still widely used. About 1878, French vineyard were threatened with downy mildew, which had been introduced from the U.S. Millardet, one of the workers assigned to the problem, noticed that where grapes near the highways to Bordeaux had been treated with a poisonous-looking mixture of copper and lime to prevent stealing, there was little or no downy mildew. A description of the preparation of bordeaux mixture was published in 1885, and it remains a most efficient fungicide. It does, however, have a most conspicuous residue and is injurious to some plants.

Hydroxyquinoline Sulfate

Chinosol
Systemic fungicide, bactericide.

Imazalil

Bromazil, Deccozil, Double R11, Flo Pro IMZ, Freshgard 700, Impala, Nu-Zone
Systemic fungicide.

Iprodione

Chipco, Kodan, Rovral, ProTurf, Fungicide X
Contact/locally systemic fungicide.

Kresoxim-Methyl

Alliage, Candit, Cygnus, Discus, Sovran, Stroby
Surface systemic fungicide; protective and curative effects.

Lime Sulfur

Polysulfides formed by boiling together sulfur and mild of lime. The standard liquid has a specific gravity of 32 Baume and the commercial product is far superior to the homemade. Lime sulfur dates back to 1851, when the head gardener, Grison, at Versailles, France, boiled together sulfur and lime for a vegetable fungicide called "Eau Grison." In 1886, this fungicide was used in California as a dormant spray for San Jose scale and later for peach leaf curl. A self-boiled lime sulfur made without heat was produced in 1908 as a summer spray for sensitive plants, but it was later replaced by wettable sulfurs for most fruit-spray programs. A dry form of lime sulfur was marketed about 1908. Used as a dormant spray for fruits, roses, and some other plants for mildews, *Volutella* blight of boxwood, and other diseases. Do not use above 85°F.

Mancozeb

AgriSolutions, Mancozeb, Penncozeb, Pennfluid, Tridex, Trimanin, Trimanoc, Trimanzone, Triziman, Triziman D, Vandozeb, Protect T/O, Mancozin, Manzin, Dithane, Fore, Manzate, Pentathlon DF, Pentathlon LF
Fungicide.

Maneb

Trimangol, Vondac, M, Manex, Manox, Man-Zox, Pentathon, Maneb Spritzpulver, Manex, Manzi
Fungicide.

Metalaxyl

Metax, Allegiance, ProTurf
Soil and foliar fungicide; seed dressing fungicide.

Metalaxyl M

Quell, Apron XL, Ridomil Gold, Subdue 2X, Subdue MAXX
Fungicide.

Metam-Sodium

Metam 426, Polefume, Turfcure, Vapam, Vapam HL, Busan 1236, Trimaton, Sectagon 42, Metam CLR
Soil fumigant – fungicide, insecticide, nematicide.

Metiram

Polyram
Contact fungicide.

Myclobutanil

Eagle, Nova, Rally, Systhane
Fungicide.

Nitrothal-Isopropyl

Pallitop
Fungicide.

Oxadixyl

Recoil, Ripost, Sandofan, Wakil
Systemic fungicide.

Oxycarboxin

Plantvax
Systemic fungicide.

Quintozene

Blocker, Parflo, Winflo, Defend, Terraclor, Turfcide, FF11, Penstar, RTU, PCNB
Soil fungicide; seed dressing agent.

Penconazole

Omnex, Topas
Systemic fungicide.

Pencycuron

Monceran, Trotis

Piperalin

Pipron
Fungicide.

Potassium Bicarbonate

Armicarb, GreenCure, Milstop
Broad spectrum fungicide; K bicarbonate plus surfactants.

Potassium Bicarbonate

Kaligreen
Fungicide; K bicarbonate, no surfactants.

Prochloraz

Abavit, Ascurit, Oczave, Omega, Prelude, Sporgon, Sportak
Fungicide.

Propamocarb

Hydrochloride (Banol, Dynone, Filex, Prevex, Previcar, Previcur N, Win)
Fungicide.

Propiconazole

PropiMaX, Alamo, Banner, Break, Orbit, Tilt, Propizole
Systemic fungicide; seed treatment.

Propineb

Antracol, Inicol
Contact fungicide.

Pyrifenox

Corona, Dorado
Systemic fungicide.

Pyroquilon

Coratop, Fongorene
Systemic fungicide.

Pyrazophos

Afugan, Curamil
Systemic fungicide.

Quarternary Ammonium Compounds

Barquat, Hyamine
Fungicide, Bactericides, Surfactants.

Sulfur

Kumulus, CSC Dusting, CSC Thioben, CSC Thiosperse, Crisazufre, Sulfox, Suffa, Sulfa, Red Ball, Microsulf, Thiolux, Thiovit, Bensul, Golden Demo Signal, Special Electric, Comoran, Comoran Supra, Cosan, Elosal, Kolodust, Kumulus, Microsperse
Fungicide, Miticide.

Tebuconazole

Corail, Elite, Folicur, Horizon, Horizon Arbo, Horizon T, Lyux, Raxil
Systemic fungicide.

Tetraconazole

Eminent
Systemic fungicide.

Thiabendazole

Arbotect, Mertect, Storite, Storite Excel, Tectab, Tecto, APL-Luster, APL Luster T, Decco 205, Brogdex, Freshgard 598, Gustafson SP
Systemic fungicide.

Thiophanate Methyl

Domain, Fungo, Mildothane, Topsin M, 3336, Fansin-M, OHP 6672
Fungicide.

Thiophanate Methyl Plus Etridiazole

Banrot
Soil fungicide.

Thiram

Tripomol, Defiant, Thiram Granuflo, Aatack, Aules, Chipco, Thiram 75, Pomarsol, Forte, Thiulin,

42-S Thiram, Rhodiasan Express, Spotrete
Fungicide, Seed protectant.

Triadimefon

Bayleton, Strike
Systemic fungicide.

Triadimenol

Bayton, Bayfidan, Cereous, Trisan, Bayton 30
Systemic fungicide.

Trichoderma Harzianum

Plant Shield, Root Shield, Top Shield
Foliar, Soil fungicide.

Tricyclazole

Blast
Systemic fungicide.

Tridemorph

Calixin
System fungicide.

Trifloxystrobin

Compass, Flint, Gem, Twist, Compass O
Fungicide.

Triflumizole

Procure, Terraguard
Systemic fungicide.

Triforine

Denarin, Funginex, Saprol
Fungicide.

Triphenyltin Hydroxide

Brestanid, Agri Tin
Fungicide.

Vinclozolin

Ronilan, Curalan, Vorlan
Fungicide.

Zineb

Cuprothex, Super Mixy
Fungicide.

Ziram

Tricarbamix, Triscabol, Cuman, Pomarsol 2
Fungicide.

BACTERICIDES

Agrobacterium Radiobacter

Galltrol-A, Strain 84, Nogall, Strain K-1026
Crown gall preventative bactericide.

Benzalkonium Chloride

Barquat, Hyamine, Nacco San
Bactericide.

Bronopol

Bronotak
Bactericide, bacteriostat.

Copper Ammonium Carbonate

Copper-Count-N
Bactericide.

Copper, Fixed

Includes Cu hydroxide, Cu oxide, Cu oxychloride sulfate, Cu oxychloride, Cu sulfate.

Copper Hydroxide

Cudrox, Cuidrox, Blue Shield, Kocide, Spin Out, KOP Hydroxide, NuCop
Bactericide.

Copper Sulfate

Basic (Cuprofix, Disperss, Cuprofix, MZ Disperss, Basic Cooper 53, Cop-O-Zinc 25-25. Basicop)
Bactericide. ►Fungicides.

Dazomet

Basamid
Bactericide, Soil fumigant.

Dimanin A

Bayclean
Bactericide.

Gallex

Bactericide, crown gall eradicant paint.

Hydroxyquinoline Sulfate

Chinosol
Bactericide.

Oxytetracycline Hydroxide

Mycoshield
Bactericide.

Quarternary Ammonium Compounds

Arquad 2C-75, Barquat, Hyamine
Bactericide.

Streptomycin (Nitrate or Sulfate)

Agricultural Streptomycin, Streptrol, Agr-Mycin 17, As-50
Bactericide.

NEMATICIDES

Carbofuran

Furadan, Curaterr
Nematicide.

Chlorpicrin

Chlor-O-Pie
Nematicide, Soil fumigant.

Dazomet

Basamid
Nematicide, Soil fumigant.

Dichloropropene

DD-92, In Line, Telone, Telone II
Nematicide, Soil fumigant.

Du Nema

Nematicide, used on turf.

Ethylene Dibromide

Nematicide, Soil fumigant.

Metam-Sodium

Busan 1236, Trimaton
Nematicide, Soil fumigant.

Triazophos

Hostathion, Trelka
Nematicide.

VIROCIDES

Cytovirin

Virus inhibitor.

APPLYING THE CHEMICALS

Spraying is the application of a chemical to a plant in liquid form; **dusting** the application of a fine dry powder. The difference between spraying and dusting was very clear-cut before aerosol bombs, mist blowers, and fog machines were developed to apply liquids in such concentrated form that the particles are practically dry before they reach the plant and before spray-dusters were made to deliver wetted dusts.

Sprayers vary from a flit gun or pint atomizer, which takes an hour to discharge a gallon, to power apparatus that discharges 60 gallons a minute at 800 pounds pressure from a 600-gallon spray tank. Dusters vary from the small cardboard or plastic carton in which the dust is purchased to helicopters. Applicators for pressurize sprays or aerosols vary from the one-pound "bomb" to truck-mounted fog generators or air blast machines. See Fig. 1.1 for various applicators.

Mist Sprayers

In orchards and in shade tree work there has been increasing use of mist blowers, air blast machines that carry droplets of concentrated pesticides to plants in air rather than water. They are speedier than hydraulic sprayers, use far less water, which may be scarce in times of drought, and do not leave puddles or poisonous run-off which may be dangerous to pets and birds. They cannot, however, be operated in much wind; for that reason, and also in order to see the distribution of the concentrates, they often have to be used at night. They are not too efficient for very tall trees, and the droplet size has to be rather carefully regulated. Too large drops may fall out before they reach a tree, and too small drops may not settle down but go on past.

Although we usually think of mist blowers on trucks for large scale operations, there are now some about the size of knapsack sprayers that, engine and all, are worn on the back around the garden. They weigh around

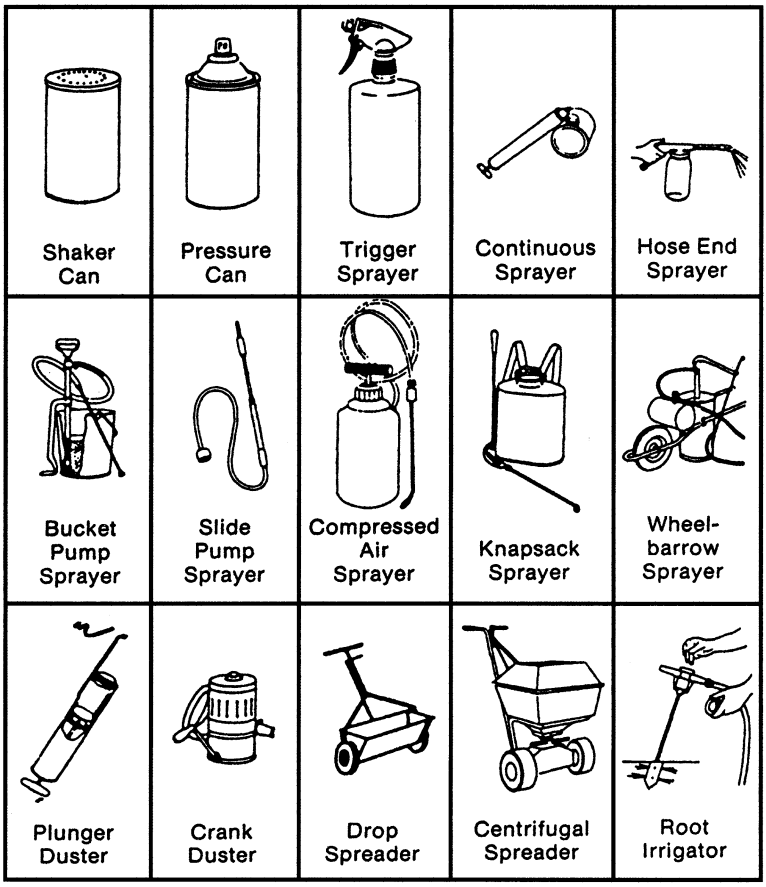

Figure 1.1 Aerosol Pressurized Spray

35 pounds and will cover foliage up to 30 feet. They cost, however, somewhat more than the hydraulic power sprayers of small estate size.

Hydraulic Sprayers

Mist blowers will probably never entirely outmode hydraulic sprayers, which can place the spray more accurately, at a greater height, and can operate under more unfavorable weather conditions. For trees, high gallonage per

Figure 1.2 Spray Application Techniques

minute and enough pressure to drive sprays high in the air have advantages, but for garden plants the emphasis should be on cutting down gallonage and pressure.

Power sprayers for home gardens are available in almost any size, from 5-gallon capacity on up, and may have gasoline or electric motors (see Fig. 1.2). For the orchard a spray gun is satisfactory, but for flowering shrubs–azaleas, roses, etc.–a spray rod, curved at the end, or with an angle nozzle, is easier on the plants and more effective, allowing for better coverage of underside of foliage.

The size of the hole in the nozzle disc and the pressure determine the amount of spray used. The volume of spray ejected per minute doubles or triples with each small increase in the hole size or pressure used. This means that in a home garden where the objective is to cover a few rose bushes effectively a large amount of spray can be wasted at too high pressure, an expensive item with many pesticide mixtures costing 20 to 30 cents a diluted gallon. Most chemicals are corrosive, and even if you start with a mist nozzle with a small hole at the beginning of the season, you will soon be delivering more spray per minute because the hole is enlarging. This usually means more conspicuous residue left on the plant as well as more expense.

Hand-Operated Sprayers

"Aerosol bombs" are pressurized sprays in push-button containers. A gas propellant reduced to liquid form is added to a pesticide concentrate and a fine mist is released when the button is pushed. Unless the container is held 12 to 18 inches away from plants, to allow the gas to evaporate, there will be some burning (more literally a freezing) when the liquid gas hits foliage. Such cans are good for house plants and for spot treatment of insects outdoors, but air currents make it difficult to place fungicides effectively. Aerosols are also used for the application of wound dressings to trees. (See Fig. 1.3).

Household sprayers of the atomizer type are intermittent, discharging spray material with each forward stroke of the pump, or continuous, maintaining constant pressure. They are too small and too tiresome to operate for more than a few plants, and it is hard to get adequate coverage of underside of foliage.

Compressed air sprayers are adequate for small gardens and are relatively inexpensive. Capacity varies from 1 to 6 gallons. They are meant to be carried slung over one shoulder, but some come mounted on a cart. Air is

Figure 1.3 Pesticide Application Equipment. (Modified from the National Sprayer and Duster Association)

compressed into the tank above the spray liquid by a hand-operated pump. A short hose, extension rod, and adjustable nozzle make it possible to cover undersurfaces. Such sprayers are a bit hard to pump up, and some models have carbon dioxide cylinders to provide operating pressure.

Knapsack sprayers, of 2 to 6 gallons capacity, are carried on the back of the operator and are pumped by moving a lever up and down with the right hand as you spray with the left. These are more expensive than compressed air sprayers, but deliver a fine continuous mist and are excellent for larger gardens.

Slide or trombone sprayers have a telescoping plunger, operated with two hands. They draw material from an attached jar or separate pail and discharge it as a continuous spray. They develop good pressure and can be used for small trees, but are tiring to use.

Wheelbarrow sprayers are manually operated hydraulic sprayers, holding 7 to 18 gallons, that are mounted on a frame with wheelbarrow-type handles and one or two wheels. Pressures up to 250 pounds may be developed, providing excellent coverage for shrubs and small trees. This type works best with two people, one to control the pump, the other to operate the spray rod.

Hose-end sprayers are attached to the garden hose so that water supplies the pressure. The action is that of a siphon. The concentrated pesticide is placed in a jar, and as water under pressure is passed over the metering jet a small amount of chemical is drawn into it. This is a very easy way to spray, and some models are relatively accurate in materials discharged. Be sure to purchase a type with an extension tube and deflector, so that spray can be directed to underside of the foliage, with a shut-off at the jar, not just back at the hose, and with a device to prevent back-siphonage. Hose-end sprayers can be used for roses and other shrubs and for low trees. The droplets may be somewhat larger than those from a wheelbarrow or knapsack sprayer, and slightly more chemical may be used.

Dusters

Pesticide dusts are most often made with talcs, pyrophyllite, clays, calcium carbonate, precipitated hydrated silicates and silicon dioxides, synthetic calcium silicate and diatomaceous earth as the diluents although finely ground plant material such as tobacco dust or walnut shell flour is sometimes used.

In some cases, a solution of the toxicant in a volatile organic solvent such as acetone or benzene is mixed with the dust diluents, the solvent allowed to evaporate, and the mixture then ground. A solution of toxicant may be sprayed on the dust diluent during mixing and grinding or the toxicant dissolved in a nonvolatile solvent and mixed with the diluent. When this is done, care must be taken to avoid an excess of solvent that might impair dusting qualities of the finished product. Many technical pesticides in solid form lend themselves to direct grinding with a sorptive clay carrier in adequate milling equipment. Field strength dusts may be produced by diluting or cutting down dust concentrates which contain from 10 to 50% a.i. (Dust Bases). Because of their good dusting properties, attapulgites, diatomite, talc, pyrophyllite, kaolins, and treated calcium carbonate are used as diluents to provide the volume per acre needed to facilitate metering of the dust through the duster mechanism. Since many formulations contain more than one a.i., dry concentrates must have the proper qualities to make a good formulation with relatively little or no diluent. From a toxicity standpoint, it is desirable to have a very small particle size, since immediate toxicity is generally inversely proportional to particle size. There are several important disadvantages to extremely small particle size: high wind losses, more or less rapid volatilization and the prohibitive cost of extremely fine grinding. Also, to obtain better toxicant exposure of technical concentrates absorbed on a carrier, it is desirable to have the extender or diluent in as large a particle size as possible and still give good dusting characteristics. In a 5% dust effective toxicant exposure is obtained with the extender averaging 10 times the size of the toxicant particles. At present, particle size specifications are usually 10 to 30 microns for ground dusters and 20 to 40 microns for aircraft units. For use in fertilizer mixtures, granulated powders of 20 to 80 mesh are prepared by impregnation of Fuller's earth and bentonite fractions with the desired toxicants.

Some dusts are sold in a can with a shaker top, meant to be applied like salt, which is certainly not going to place a fungicide where it will do the most good. Some dusts are sold in small cardboard cylinders to be used as dusters, which work for a little while if the cardboard is well paraffined to slide easily; but the dust soon gets damp and clogs. Many more dusts are sold in plastic containers, with the dust supposedly coming out in clouds as you squeeze, but more often it doesn't after the first few days. Dusts are tricky to use because of these disadvantages.

SPRAYING VS DUSTING

There is really no answer to the question of whether it is better to dust or to spray. In most gardens you will do both, depending on the weather, the plant, the fungicide you want to use, and how much time and help you have.

Some orchardists prefer dusting because they can get around the trees quickly in a rain, whereas to apply a spray they must wait until the foliage is dry. But for ornamentals exactly the opposite is true! You cannot dust a shrub even slightly wet with rain or dew without having a hideous splotchy effect that persists for a long time. If absolutely necessary you can spray while the plants are still slightly wet, though the spray may not stick quite as well, and you may want to make the next application a bit sooner. It is easier to spray than to dust on a windy day. Also, in dusting you are somewhat more likely to get possibly toxic materials into your lungs than in spraying. The chief points in favor of dusting are the ease and speed of application and the fact that you do not have to clean out the duster after each dusting.

Sprayers have to be cleaned, often between different sprays, and they must be rinsed with at least two changes of water pumped through the system at the end of every day. Occasionally they must be taken apart, the tank soaked in trisodium phosphate or washing soda, the strainers and nozzles in kerosene, wire run through the spray rods, then all put together and rinsed with water.

MIXING THE CHEMICALS

It still seems incredible that so many gardeners continue to treat their plants in a haphazard fashion. Buy a set of measuring spoons and a measuring cup, marked in ounces. Buy a large pail and mark it off in gallons. Then measure, exactly!

Dosage directions are usually given in pounds per 100 gallons of water, with or without translation on the label into small amounts. Not much arithmetic is required to figure a smaller dosage, if you remember a few measurements:

Conversion Table

3 teaspoons	= 1 tablespoon
2 tablespoons	= 1 fluid ounce
16 tablespoons, 8 fluid ounces	= 1 cup
16 ounces, 2 cups	= 1 pint
2 pints, 4 cups	= 1 quart
16 cups, 8 pints	= 4 quarts = 1 gallon
1 acre	= 43,560 square feet

Suppose 3 gallons of a 2 to 100 dilution of lime sulfur is desired. That is the same as a 1 to 50 dilution. Three gallons constitute 48 cups; so if 1 cup of liquid lime sulfur is added to 3 gallons, you will have a 1 to 49 dilution, and that is close enough.

Or suppose you want to make 4 gallons of Zineb at the rate of 1 1/2 pounds per 100 gallons. That is 24 ounces per 100 gallons, or .24 ounce for 1 gallon and .96 ounce for 4 gallons. That is approximately 1 ounce to weigh on your small scales. It also works out at about 1 level tablespoon of the Dithane powder per gallon, and it is easier to measure than to weigh. There is, however, a good deal of volume variation, depending on how fluffed up the material is at the time you measure it; so weighing is preferable.

When you buy chemicals in small packages designed for the home garden, the dosages given on the labels will probably be in terms of tablespoons per

gallon, and you need only follow directions. When, to save a good deal of expense, you buy the larger sizes intended for farmers, the directions may be given only in terms of pounds per 100 gallons. As a very rough rule of thumb, you can figure 1 tablespoon per gallon where directions call for 1 pound per 100 gallons, but the different mixtures have different weights so this is not very accurate.

At the rate of 1 pound to 100 you would use, accurately, 3/4 T captan 50%, 1 T chloranil (Spergon), 1/3 T copper sulfate, 2/3 T dichlone 50% (Phygon), l 1/4 T ferbam, 1/2 T maneb, 1 T spray lime, 3/4 T thiram, 1/2 T sulfur, 2/3 T zineb (Dithane Z-78 or Parzate), l 1/4 T ziram to 1 gallon of water.

Sometimes materials for soil treatment are given in pounds per acre. Knowing that one acre contains 43,560 square feet, you can make a proportion to find out how many pounds are required per 1000 square feet.

ALL-PURPOSE SPRAYS AND DUSTS

The practicability of combination insecticide-fungicide mixtures is sometimes argued. The proprietary compounds are more expensive, but they are more properly prepared than can be done at home and certainly save a lot of time. Nobody today could put on in separate applications all the materials needed. The trouble is that the mixtures follow fads, as in human medicine. Just as penicillin was given for most human ills some years ago, so DDT was put in almost all pesticide mixtures, followed a little later by malathion. Both are excellent insecticides. The trouble is they are somewhat too efficient, killing the parasites and predators that keep mites and some other pests in check and also damage the environment. DDT is no longer available. Some of the new fungicides leave a rather conspicuous residue; some are somewhat phytotoxic under certain conditions. Some of these pesticides are no longer available owing to new federal pesticide legislation; however, new materials are available that will replace those whose use is illegal. Every mixture must be evaluated for particular climatic situations and kinds of plants. There are hundreds and hundreds of combinations on the market under brand names. In order not to be out of date before this text is printed, I have used as few brand names as possible.

INTEGRATED PEST MANAGEMENT

Pesticides have been constantly scrutinized since Rachel Carson's book Silent Spring in the early 1960's and the birth of the U.S. Environmental Protection Agency (EPA) in the early 1970's. Registrations of many pesticides have been canceled and more will be canceled with the passage of the Food Quality Protection Act (FQPA) in 1996. The diminished availability of pesticides may limit choices to more costly materials. In addition, there is growing concern about groundwater contamination by pesticides and fertilizers, consumer exposure to pesticide residue on food and plant material, pesticide resistance in plant pathogens, insects and weeds, destruction of beneficial organisms, atmospheric contamination by pollutants, and concern for endangered species, all of which combine to make the problem of pest control more serious.

For the past 30 years integrated pest management (IPM) has received increased interest. Investigations have concentrated on enhancement of a broad arsenal of integrated strategies for control of pests and diseases on selected commodities. A key goal of IPM strategies is the reduction of pesticide use to the absolute minimum and the reliance on other strategies to assist in controlling pests. IPM strategies which can be used include:

- apply pesticides only when necessary;
- make use of application methods that apply less pesticide or use a more efficient spray system;
- use biocompatible chemicals as they become available;
- use biological controls when available and when appropriate; and
- use cultural practices which are favorable to healthy plant growth.

A successful IPM program depends on four basic techniques.

- Scouting. Regular and random visual observations provide early warning to disease problems.
- Disease Identification. The first and most important step is to identify the problem; misdiagnosis results in use of improper control.

- Timing. Improper timing of control measure will result in disease control failure; the control measure must be timed correctly to the stage of disease development.
- Records. Brief accurate records are a good tool for disease control decisions.

Although entomologists have achieved some success with biological controls, the successes by plant pathologists with biological control has been somewhat sparse. While use of classical biological control has aided pest control, most biocontrol products have not yet proved to be preferred treatments for disease control. Intense research in biological control of root diseases has been proceeding in the United States and in Europe. Some microbial agents, although sometimes sensitive to environmental variation, can be effective in controlling soil-borne plant pathogens. Although there are many promising fungal and bacterial biocontrol agents, and experiments demonstrate successful biocontrol in the greenhouse and field, there are few commercially available biocontrol products. The reasons may be due to:

- an insufficient understanding of the mode of action of most biocontrol agents;
- to need to develop mass production and delivery systems;
- little methodology for integrating biocontrol with other control strategies and crop production methods; and
- competition of the biocontrol agent with other microorganisms.

It should also be recognized that biocontrol products are effective against specific pathogens and that the use of pesticides on foliage or soil may have detrimental effects on the biocontrol agent.

There have been searches in recent years for “natural” substances that may bear profound antifungal/antibacterial properties and that exhibit low mammalian and environmental toxicities. These chemicals are termed biocompatible and there are four of interest:

- Neem from the neem tree (Melis azedarach)
- Bicarbonates (used in baking)
- Horticultural oils
- Strobilurins (from fungal extracts)

Some of these have now been formulated for the commercial market and are exhibiting excellent disease control. There are numerous biocompatible chemicals under investigation for their efficacy in disease and pest control. The great benefit of these products is their safety for the user and the environment.

Chapter 2
Classification of Plant Pathogens

The plant diseases described in this handbook are caused by bacteria, fungi, nematodes, a few seed plants (such as dodder, mistletoe, and witchweed), viruses, physiological disturbances, and air and water pollutants. The classification of bacteria, fungi, and viruses is somewhat involved and is given here as a background for the specific descriptions in ►Chap. 3. There are many classifications of bacteria, fungi, and viruses, with numerous disagreements among mycologists, bacteriologists, virologists and plant pathologists. Names and groups have been chosen that are widely accepted and most readily adapted to the alphabetical requirements of a reference that works like a dictionary.

Classification of the bacteria is based on that given in the Volume 1 (1984) and Volume 2 (1986) of *Bergey's Manual of Systematic Bacteriology*, and *Laboratory Guide for Identification of Plant Pathogenic Bacteria* (1980) by N. W. Schaad (Editor). Classification of the viruses is based on that given by Murphy, et al. 1995. *Virus Taxonomy, Classification, and Nomenclature of Viruses*. 6th Rept. ICTV, Brunt, A. A. et al. 1996. *Virus of Plants. Descriptions and List from the VIDE Database*, Van Regenmortel et al. 1999. *Virus Taxonomy*. 7th Report. ICTV and *Descriptions of Plant Viruses*, published by the Commonwealth Mycological Institute and Association of Applied Biologists. Other helpful sources were *European Handbook of Plant Diseases* (1988) by I. M. Smith, J. Dunez, R. A. Lelliott, D. W. Phillips and S. A. Archer and *A Textbook of Plant Virus Diseases*, 1972 edition, by Kenneth M. Smith.

So far as possible, the genera, orders, and families of fungi agree with those given in *Plant Pathogenic Fungi* (1987) by J. A. von Arx. Helpful sources included *A Dictionary of the Fungi*, 1961 edition, by G. C. Ainsworth and

G. R. Bisby, which includes G. W. Martin's *Key to the Families of the Fungi*; *The Genera of Fungi*, by F. E. Clements and C. L. Shear; *The Fungi*, by Frederick A. and Frederick R. Wolf; *The Lower Fungi: Phycomycetes*, by H. M. Fitzpatrick; *Morphology and Taxonomy of Fungi*, by E. A. Bessey; and *Illustrated Genera of Imperfect Fungi*, by H. L. Barnett and B. B. Hunter.

Classification in accordance with convention or law is called *taxonomy*. Common names vary from locality to locality and country to country. Scientific names are international and are based on the binomial system. Each kind of bacterium, fungus, nematode, or higher plant is a species, and it has two Latin words for its name. The first name indicates the genus to which the species belongs, and the second the species itself. The latter name is usually descriptive. *Diplocarpon rosae* means that *Diplocarpon*, the blackspot fungus, is found on rose. Sometimes the species name honors a person, as *Coniothyrium wernsdorffiae* for the fungus causing brand canker of rose. Such a species name, derived from a proper name, has sometimes been written with a capital, but present custom is to decapitalize all species names. The names of genera should always be written with a capital.

Correctly, the author of the name should be written after the species. Then, if someone else places the species in a new genus, the name of the first author is put in parentheses followed by the name of the second author. When a number of taxonomists have worked on a group, the list of authors gets quite unwieldy. For simplicity all authors have been omitted from the scientific names in this text. The correct name for a fungus with more than one stage is that first given, with a valid description, for the teleomorph or sexual stage. That rule is followed here with a few exceptions–as when a fungus is almost universally recognized by another name.

Species are grouped into genera, related genera into families, designated with the suffix *aceae*, as Erysiphaceae, and families into orders with the suffix *ales*, as Erysiphales. Groups of related orders form classes.

Strange as it may seem, scientists are not yet agreed on what constitutes a plant or even a living organism. The old definition of bacteria as unicellular plants is disputed, and some question if fungi are truly plants. Bacteria are prokaryotes. Prokaryotes are generally single-celled microorganisms that have a cell membrane or a cell membrane and a cell wall surrounding the cytoplasm and no organized nucleus. Eukaryotes contain membrane-bound nuclei, mitochondria and – in plants only – chloroplasts. Although viruses are known to multiply inside their hosts or vectors, the question of their being a living entity has not been resolved. The arguments continue. Meanwhile

entities have to be grouped into some sort of order. Whittaker in 1969 introduced the five (5) kingdom classification for all living organisms: Monera (or Procaryota), Protista, Animalia, Plantae and Fungi (or Mycota). The Monera are organisms with small cells lacking nuclei, mitochondria and plastids, viz. the bacteria. The Protista include Microorganisms with one-celled, often motile thalli (cells contain nuclei). The plants, animals and fungi are believed to have evolved from Protista. The Fungi are characterized as heterotrophic organisms, dependent on organic food, which they absorb. The following scheme, adapted from the *Plant Pathogenic Fungi*, Nova Hedwigia 87: 288 pp. by J. A. von Arx, is an attempt to show the position of fungal plant pathogens in the Kingdom Mycota. The listing of families is restricted to those containing such pathogens.

FUNGI

Fungi are organisms having no chlorophyll, reproducing by sexual and asexual spores, not by fission like bacteria, and typically possessing a mycelium or mass of interwoven threads (hyphae) containing well-marked nuclei. According to Hawksworth (1991), there are about 4300 valid genera, and many more that are synonyms, and about 70,000 species living as parasites or saprophytes on other organisms or their residues. More than 8000 species cause plants disease. Fungi are divided into three kingdoms and eleven phyla.

Kingdom: Fungi
Phylum: Chytridiomycota
Phylum: Zygomycota
Phylum: Ascomycota
Phylum: Basidiomycota
Kingdom: Stramenopila
Phylum: Oomycota
Phylum: Hyphochytriomycota
Phylum: Labyrinthulomycota (slime molds)
Kingdom: Protists
Phylum: Plasmodiophoromycota (endoparasitic slime molds)
Phylum: Dictyosteliomycota (Dictyostelid slime molds)
Phylum: Acrasiomycota (Acrasid slime molds)
Phylum: Myxomycota (true slime molds)

Oomycetes, Zygomycetes and Chytridiomycetes were formerly listed as subclasses within the class Phycomycetes. Oomycota, Zygomycota and Chytridiomycota are now generally accepted as separate phyla of fungi. The mycelium of these three phyla has many nuclei which are not marked off by cross-wells (or nonseptate mycelium) except where reproductive structures arise, a condition known as coenocytic. Asexual reproduction is by means of spores borne in sacs called sporangia. The Zygomycota have sexual spores called zygospores which are formed by the union of two similar sex cells

or gametes; the Oomycota have sexual spores called oospores formed from dissimilar gametes; the Chytriodiomycota have neither type of sexual spore; the Ascomycota have septate mycelium and sexual spores in asci; the Basidiomycota have septate mycelium, frequently with clamp connections, and sexual spores; the Myxomycota have thalli as a motile mass of protoplasm (a plasmodium or myxamoeba – no mycelium) which is transformed into a mass of small, aseptate resting spores that on germination form motile cells with or without flagella. The Myxomycota include protists with amoeboid thalli and their status as fungi often has been questioned. The thalli of the Myxomycota are naked, amoeboid, plasmotic masses without cell walls and are termed plasmodia or pseudoplasmodia. They are also able to move by the formation of pseudopodia and by plasma-streaming. The Plasmodiophoromycetes is the only class of the Myxomycota which includes parasites of vascular plants. The best known species is *Plasmodiophora brassicae*, which causes "club root" of cabbage.

Chytridiomycota

The thalli are usually vesicular, occasionally filamentous, and are transformed to sporangia, gametangia or resting spores. The Chytridiomycetes are the only members of the kingdom Fungi that produce motile cells. Motile cells may function as zoospores, or as gametes, are radially symmetrical, with a single, posteriorly directed whip-lash type flagellum. The Chytridiomycetes are the only class in this phylum.

Chytridiales

This order is defined on the basis of zoospore ultrastructure. Most members are water- or soil-inhabiting fungi; many of the former are parasitic on algae and water molds, many of the latter on vascular plants. A few parasitize animal eggs and protozoa while others are saprobic on the decaying remains of dead plants. Simple fungi which have almost no mycelium, the thallus at maturity acting as a single sporangium, or dividing to become a sorus of sporangia; zoospores posteriorly uniflagellate.

Spizellomycetales

Members of this order are diverse and include plant and fungal parasites and free-living saprobes inhabiting both soil and water. There is great morpho-

logical variation in the group, and examples of both endogenous and exogenous development. Most species are monocentric.

Blastocladiales

Saprophytes in water or soil; genera are characterized by thick-walled, resistant sporangia, usually with pitted walls. Another feature is the prominent membrane-bound nuclear cap present in zoospores and planogametes.

Monoblepharidales

Saprophytes in water, most of which grow on submerged twigs and fruit; thallus of much-branched delicate hyphae.

Plasmodiophorales

The placement of this order has always been uncertain. Some put it with the Myxomycetes, the slime molds, others between the Myxomycetes and the true fungi. Some have considered it a family in the Chytridiales. This single class is placed in the kingdom, Protists, phylum, Plasmodiophoromycota which contains a single class, Plasmodiophoromycetes. There is also only one family, Plasmodiophoraceae, in this order. Parasitic, assimilative phase a multinucleate thallus within host cells, chiefly of vascular plants, often causing hypertrophy; germinating in place by amoeboid, occasionally uniciliate, zoospores.

Plasmodiophoraceae. The only family in this order but with two important genera: *Plasmodiophora*, causing club root, and *Spongospora*, causing potato scab.

Oomycota

The thalli may be vesicular, often irregular, but are usually filamentous. Sporangia on germination release biflagellate zoospores. One flagellum is the whip-lash type and the other the tinsel type. Motile sex cells are absent. Sessile gametangial cells conjugate and form an oogonium containing one or several egg cells (see Fig. 2.1).

The Oomycota are related to autotrophic algae with similar characters. The Oomycetes are the only class in this phylum; however, the small classes Hyphochytriomycetes and Labrinthulomycetes may also be included.

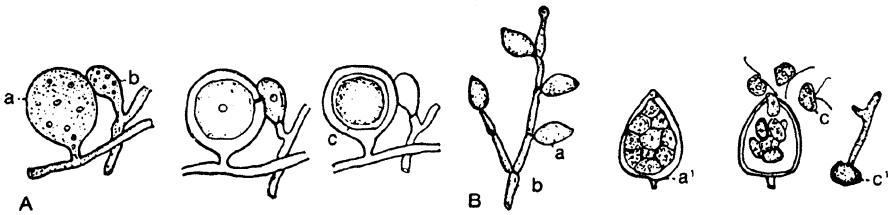

Figure 2.1 Reproduction of an Oomycete (*Phytophthora*, order Peronosporales). **A** multinucleate oogonium (*a*) and male antheridium (*b*) in contact; fertilization tube formed between gametes after all nuclei except one has disintegrated; thick-walled oospore (*c*) formed inside oogonium. **B** asexual reproduction by sporangium (*a*) formed on sporangiophore (*b*); a^1 sporangium germinating by formation of ciliate zoospores; c^1 zoospores germinating with germ tube

Hyphochytriales

Zoospores anteriorly uniflagellate, usually formed outside the sporangium. The order Hyphochytriales has now been placed in the phylum Hyphochytriomycota which contains a single order, Hyphochytriales.

Saprolegniales

Marine forms, parasites of diatoms and algae, or in fresh water and soil, the water molds, with abundant mycelium; hyphae without constrictions; oogonium with several oospores.

Leptomitales

Water forms; hyphae constricted, with cellulin plugs; oogonium with a single oospore.

Lagenidiales

Primarily aquatic, mostly parasitic on algae and water molds; thallus simple; zoospores formed by cleavage within sporangium or partly or wholly in an evanescent external vesicle.

Peronosporales

Downy mildews and white rusts. Primarily terrestrial, living in soil or parasitic on vascular plants; in the latter case, zoosporangia function as conidia.
Albuginaceae. The white rusts. Conidia (sporangia) in chains on club-shaped conidiophores borne in dense sori beneath epidermis of host, the sori forming white blisters; intercellular mycelium with globose haustoria.

Pythiaceae. Conidiophores differing little from assimilative hyphae; mycelium saprophytic or parasitic, but if latter within cells and without haustoria. Two genera, *Phytophthora*, which includes the potato blight and other pathogens, and *Pythium*, causing damping-off, are especially important.

Peronosporaceae. Downy mildews. Conidia are borne singly or in clusters at tips of usually branched, rarely clavate, conidiophores emerging through stomata; haustoria various.

Zygomycota

The thalli are vesicular, or more often represent a coenocytic, multinucleate mycelium (with aseptate hyphae). The gametangial cells conjugate and form a thick-walled, persistent resting spore, called a zygospore (see Fig. 2.2). Motile sex cells are absent, but sporangiospores and conidia are usually formed and dispersed by air. There are two classes, the Zygomycetes, and the Trichomycetes (mainly parasitic on insects). These classes differ by morphological and chemical characteristics.

Zygomycetes

Mucorales

Profuse mycelium, much branched; asexual reproduction by sporangia or conidia; sexual reproduction by zygospores from union of two branches of

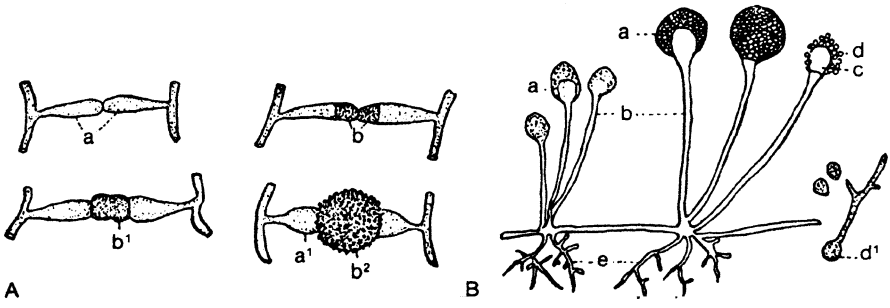

Figure 2.2 Reproduction of a Zygomycete (*Rhyzopus*, order Mucorales). **A** suspensors (*a*) from different hyphae cut off gametes (*b*) of equal size which fuse (b^1) to form a spiny zygospore (b^2). **B** asexual sporangiospores (*d*) formed inside a sporangium (*a*) formed on a sporangiophore (*b*) around a columella (*c*). Hyphae are attached to substratum by rhizoids (*e*). Sporangiospore germinates by a germ tube (d^1)

the same mycelium or from different mycelia. Some species damage fruits and vegetables in storage. Only two families are of much interest to plant pathologists.

Mucoraceae. Sporangiophores liberated by breaking up of thin sporangial wall; zygospores rough. *Mucor* and *Rhizopus* cause storage molds.

Choanephoraceae. Both sporangia and conidia present, the latter borne on swollen tips; zygospores naked. *Choanephora* is a weak parasite causing blossom blight or blossom-end rot of young fruits.

Entomophthorales

Profuse mycelium, species frequently parasitic on insects or other animals, rarely on plants; anamorph spores modified sporangia functioning as conidia; zoospores free within a gametangial vesicle.

Ascomycota

The thalli may consist of aseptate yeast cells or septate hyphae. Following meiosis, endogenous spores (ascospores) form within a cell called an ascus. There are three groups: Archiascomycetes (members lack ascogenous hyphae and ascocarps, and asci sometimes homologized with sporangia), Saccharomycetales (Ascomycetes, Yeasts: contain no ascogeneous hyphae and ascocarps; asci thin walled and may release ascospores by deliquescing or breaking) and Filamentous Ascomycetes (with functional sex organs – possess ascogonium, ascogenous hyphae and crosiers that become enclosed in an ascocarp). The asci in Ascomycetes are aggregated in fructifications called ascomata (apothecia, cleistothecia, perithecia). The asexual states (anamorphs) of the Ascomycetes usually are classified in a separate class called Deuteromycetes.

Ascomycetes

The diagnostic characteristics of this class are a septate mycelium (hyphae with cross walls) and the ascus, a sac, typically club-shaped or cylindrical, bearing the sexual spores, ascospores, usually eight in number. Asci may be formed on or in hyphae or cells but are usually grouped in structures, ascocarps, either in locules in a stroma or lining a cup-shaped fruiting body called

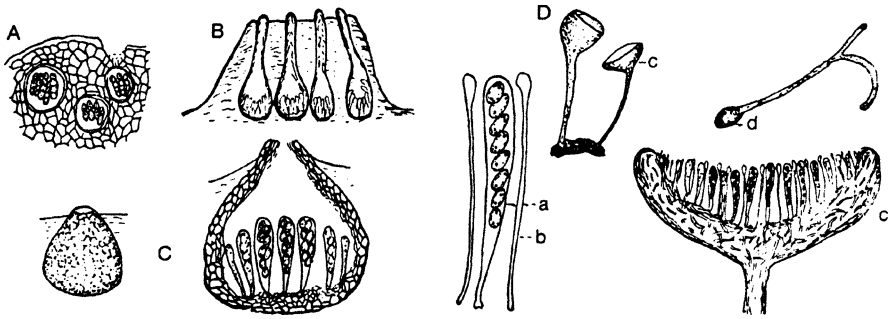

Figure 2.3 Sexual reproduction in the Ascomycetes. **A** asci borne singly in locules in stroma (Myriangiales). **B** perithecia with long necks or beaks immersed in stroma (Sphaeriales). **C** papillate perithecium in host tissue, opening with a mouth or ostioles (Spaheriales). **D** Discomycetes (Heliotiales), ascus (*a*) and paraphyses (*a*) formed in a hymenial layer in a cuplike apothecium (*c*) and (c^1); ascospore (*d*) germinates by germ tube

an apothecium or the walls of an enclosed round or flask-shaped perithecium. The young ascus has two nuclei, which fuse and then undergo generally three divisions to give the eight spores. In many genera paraphyses, thin sterile clubs, are formed between the asci (see Fig. 2.3).

Many ascomycetes have both a parasitic and a saprophytic stage. In their parasitic stage they usually produce conidia or anamorph spores, sometimes on groups of conidiophores growing out of the mycelium, sometimes in a special pycnidium. Similar structures sometimes found are spermagonia containing spermatia, small sex cells.

Taphrinales

This order is now placed in the class Archiascomycetes. Hyphae bearing terminal chlamydospores or ascogenous cells, each of which produces a single ascus, usually forming a continuous hymenium-like layer on often modified tissues of hosts. Spore sac compound (a synascus) regarded as equivalent of numerous asci. Parasitic on vascular plants.

Protomycetaceae. Chlamydospores thick-walled, germinating after a rest period, the exospore splitting and the endospore emerging to form a large multispored spore-sac. Parasitic on vascular plants.

Taphrinales. Chlamydospores thin-walled; asci eight-spored but may become multispored by budding. Genera *Exoascus* and *Taphrina* cause leaf curl and leaf blisters and now *Exoascus* is usually considered a synonym of *Taphrina*.

Subclass **Euascomycetidae**. Asci borne in ascocarps.

Eurotiales

The order is characterized by 1) asci free on mycelium or within sessile or stipitate ascocarps; 2) sexual fusion, usually by trichogyne and undifferentiated hypha; 3) spherical-to-ovoid evanescent asci; 4) single-celled ascospores that are oblate, spherical, globosa, or smooth or with reticulations, spines, or thickened rings; sometimes with appendages; 5) dry usually phialidic conidia; and 6) being known from a variety of often starchy, oily, or cellulosic substrates.

Trichocomaceae. Diversity of coverings are found over the asci: pseudoparenchymatous
cleistothecia; stromata in which cleistothecia develop; stromata without cleistothecia; or wefty hyphal coverings over the asci.

Pseudeurotiaceae. Species have coiled ascocarp initials, hyaline, to dark cleistothecia, and scattered globose asci that are evanescent.

Ouygenales

This order characterized by asci free on mycelium; fusion of gametangial hyphae variable without trichogyne but with ascogonium sometimes coiling; spherical to ovoid deliquescent asci; single-celled ascospores variously shaped.

Gymnoascaceae. Cloistothecia around asci of loosely interwoven hyphae.

Onygenaceae. Ascocarp stalked and capitate, small to medium; peridium tough, opening above; ascospores pitted.

Erysiphales (Perisporiales)

Parasites of higher plants; mycelium generally on surface of host; perithecia without true ostioles. The powdery mildews. White mycelium, with conidia in chains; perithecia rupturing with an apical tear or slit.

Meliolales

Dark or black mildews. Mycelium dark; stroma unilocular, resembling a perithecium. Mycelium dark; asci exposed by gelatinization of upper portion of ascocarp.

Myriangiales

Stroma well developed, often gelatinous; asci borne singly in locules. Nearly all are parasites on higher plants.

Piedraiaceae. Tropical fungi invades cuticle of hair of primates, including humans.
Myriangiaceae. Stroma pulvinate, often with lobes, nearly homogeneous.
Elsinoaceae. Stroma effused, with gelatinous interior and crustose rind.

Dothideales

Mycelium immersed in substratum; stroma with hard, dark rind, soft and pale within; locules more or less spherical, resembling perithecial cavities.
Capnodiaceae. Sooty molds. Often on living plants associated with insect secretions. Stroma massive, carbonaceous, often excessively branched; fruiting bodies borne singly at tips of branches, resembling perithecia. This family is now placed in the order Capnodiales.
Coryneliaceae. Stroma lobed, each lobe with a single locule which is finally wide open. Martin places this in the Coryneliales.
Dothideaceae. Stroma not markedly lobed, locules immersed in groups; at maturity stroma is erumpent and superficial.
Acrospermaceae. Stroma typically uniloculate, clavate, erect; dehiscence by a fimbriate, often spreading, tip.
Martin places this family in the Coryneliales and adds, under Dothideales, Pseudo-sphaeriaceae, with asci more or less separated by stromatic tissue.
Microthyriaceae (including Asterineae and Trichopelteae). Stromatic cover of radial or parallel hyphae; chiefly tropical species.

Microthyriales

Mycelium largely superficial; stroma flattened; dimidiate; opening by a pore or tear, simulating the upper half of a perithecium.
Polystomellaceae (including Stigmateae). Mycelium largely internal, forming a hypostroma; fruiting stroma subcuticular or superficial.
Trichothyriaceae. Superficial mycelium irregular or lacking; base of stroma well developed; parasitic on other fungi.

Pleosporales

Ostiole an elongated slit on a usually flattened, elongate apothecium, bearing asci in a flat, basal layer.
Hysteriaceae. Ascocarps superficial from the first; black, carbonaceous, round or elongate.

Micropeltaceae (Hemisphaeriaceae). Internal mycelium scanty; stromatic cover not of radially arranged hyphae; chiefly tropical species. This family now placed in order Pleosporales; formerly in Microthyriales.

Hypocreales

Perithecia, and stromata if present, bright colored, soft, and fleshy. Martin gives two families.

Nectriaceae. Asci elliptical to cylindrical; inoperculate; ascospores various but never long-filiform.

Clavicipitaceae. Asci long-cylindrical, with a thickened tip, ascospores long-filiform.

Sphaeriales (Pyrenomycetes)

Mycelium well developed; perithecia dark, more or less hard, carbonaceous, with an ostiole typically circular in section; with or without stromata; asci inoperculate (without a lid) but spores discharged with force; paraphyses and periphyses usually present.

Chaetomiaceae. Perithecia superficial, hairy, walls membranous; asci deliquescent; ascospores dark; paraphyses wanting. Now placed in order Sordariales.

Sordariaceae (Fimetariaceae). Perithecia superficial, walls membranous, naked or sparsely setose; asci discharging spores forcibly. Now placed in order Sordariales.

Sphaeriaceae. Perithecia superficial, walls carbonaceous, mouths papillate.

Ceratostomataceae. Perithecia superficial, carbonaceous, with long, hair-like beaks.

Cucurbitariaceae. Stroma present but perithecia completely emergent at maturity; formed in groups.

Amphisphaeriaceae. Bases of perithecia persistently immersed in stroma; mouths circular.

Lophiostomataceae. Bases of perithecia persistently immersed in stroma; mouths compressed, elongate.

Sphaerellaceae (Mycosphaerellaceae). Perithecia immersed in substratum; stroma lacking or poorly developed; asci not thickened at tips; mouths of perithecia papillate.

Gnomoniaceae. Perithecia immersed in substratum; usually beaked; asci thickened at tips. This family has been eliminated: Gnomonia species are in the order Dothideales.

Clypeosphaeriaceae. Stroma a shieldlike crust (clypeus) over perithecia, through which necks protrude.
Valsaceae. Stroma composed of mixed host and fungal elements; perithecia immersed, with long necks; conidia borne in cavities in stroma.
Melanconidiaceae. Like Valsaceae but conidia borne superficially on the stroma.
Diatrypaceae. Stroma composed wholly of fungus elements; in some genera present only in conidial stage; perithecia develop under bark; ascospores small, allantoid, hyaline to yellow-brown. This family now placed in order Xylariales.
Melogrammataceae. Conidia typically borne in hollow chambers in stroma composed of fungal elements; ascospores one- to many-celled, hyaline or brown.
Xylariaceae. Conidia borne in superficial layer on surface of stroma; ascospores one- to two-celled, blackish brown.
Martin does not use the order Sphaeriales. He places some of the above families in separate orders. This family now placed in order Xylariales.

Laboulbeniales

Minute parasites on insects or spiders; mycelium represented by a small number of basal cells functioning as haustorium and stalk.

Phacidiales (= Rhytismatales)

Discomycetes in which the hymenium is covered by a membrane until ascospores are mature, then splitting stellately or irregularly.
Phacidiaceae. Ascocarps leathery or carbonaceous, black, remaining embedded in host tissue or in stroma; hypothecium thin.
Martin includes Tryblidiaceae, ascocarps leathery, immersed, hypothecium thick; but Ainsworth and Bisby place members of this family in the Helotiales.

Helotiales

Discomycetes without a membrane; asci inoperculate, opening with a definite pore. Cup fungi.
Geoglossaceae. Ascocarps calvate or caplike, hymenium covering convex upper portion.

Ascocorticiaceae. Fructification effused, indeterminate, without excipulum; paraphyses lacking.
Stictidiaceae. Ascocarps first immersed in substratum, then erumpent; asci long-cylindrical with thickened apex; ascospores filiform, breaking up into segments at maturity.
Cyttariaceae. Ascocarps compound, in form of subglobose stromata bearing numerous apothecial pits. Now placed in order Cyttariales; no family.
Patellariaceae. Apothecia leathery, horny, cartilaginous, or gelatinous; tips of paraphyses united to form an epithecium; asci thick-walled. Now placed in order Patellariales; no family.
Mollisiaceae. Apothecia waxy or fleshy; peridium of rounded or angular, mostly thin-walled, dark cells forming a pseudoparenchyma.
Helotiaceae. Apothecia soft, fleshy, stalked; peridium of elongate, thin-walled, bright-colored hyphae, arranged in parallel strands.
Sclerotiniaceae. Apothecia arising from a definite sclerotium or stromatized portion of the substratum; stalked, cup-shaped, funnel-form, or saucer-shaped; usually brown; asci inoperculate, usually 8-spored; spores ellipsoidal, often flattened on one side, usually hyaline; spermatia globose to slightly ovate; conidial forms lacking in many genera.
These families are from Martin's 1954 *Key to Families*. His 1961 list puts Ostropaceae in the Ostropales and Patellariaceae in the Hysteriales. Ainsworth and Bisby list Geoglossaceae and put all other genera under "other Helotiales."

Pezizales

Asci operculate, opening by a lid; hymenium exposed before maturity of spores; apothecia often brightly colored; most forms saprophytic.
Pezizaceae. Apothecia cup-shaped or discoid; sessile or stalked.
Helvellaceae. Fruit bodies upright, columnar or with a stalk and cap; sometimes edible.

Tuberales

Ascocarp hypogeic, remaining closed; hymenium covered with a pseudotissue or hymenium lacking and asci filling cavities; mostly subterranean; includes edible truffles.
Tuberaceae. Interior waxy at maturity; asci persistent. This family now placed in order Pezizales. The order Tuberales has been eliminated.

Elaphomycetaceae. Interior powdery at maturity; asci disappearing early, leaving interior filled with spores. This family now placed in order Pezizales. The order Tuberales has been eliminated.

Basidiomycota

The thalli may contain budding cells which are formed successively by new inner layers which burst through the outer layers. After meiosis, the haploid cells are formed exogenously by budding and are called basidiospores or sporidia. Endogenous spores (sporangiospores or ascospores) are absent in Basidiomycota.

The structures on which haploid spores resulting from meiosis are formed are termed basidia and usually bear a constant number of spores, 2 or 4, occasionally more. The basidia are differentiated on dikaryotic hyphae usually in or on fruiting bodies called basidiomata. The basidia may also be formed on resting spores called teliospores (see Fig. 2.4). Dikaryotic resting spores may also germinate with a shorter or longer tube, which is termed promycelium.

The three classes now distinguished are the Ustomycetes, the Urediniomycetes and the Basidiomycetes.

The Ustomycetes propagate mainly by budding cells; septate hyphae may be present, but are rare. After meiosis, resting spores form short, often septate promycelia, which produce budding cells laterally or terminally. Characteristic basidia or basidiospores are absent.

The Urediniomycetes form basidia, which after meiosis form uninucleate cells by transverse septation. Each cell forms a single, stalked basidiospore.

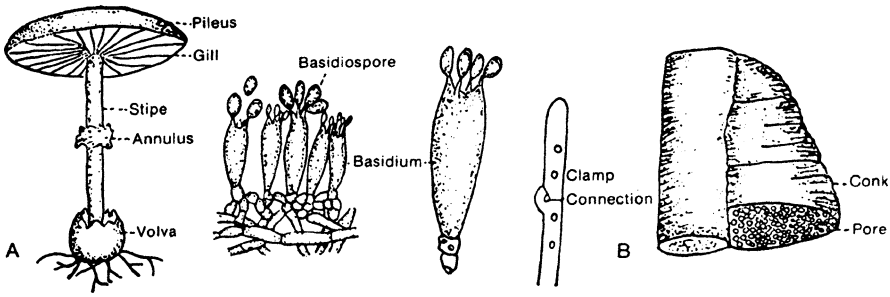

Figure 2.4 Reproduction in Basidiomycetes. **A**, mushroom (Agaricaceae) with cap of pileus lined with gills bearing basidia germinating by basiodiospores. **B**, sporophore, or conk, in Polyporaceae where basidia line pores instead of gills. Mycelium in basidiomycetes sometimes have a structure around a septum called a clamp connection

Nearly all Uredinomycetes are obligate parasites of vascular plants and are known as rust fungi.
The Basidiomycetes form basidia, which usually remain aseptate after meiosis; the basidiospores are arranged in an apical whorl and are sessile or stalked. The septa of the hypha have characteristic central pores termed dolipores, with thickened walls and caps. Dolipores are not present in the Ustomycetes and the Urediniomycetes.

Ustomycetes

Ustomycetes include about 500 species belonging to two orders; the plant parasitic Ustilaginales (smut fungi), and the Sporidiales (red yeasts).

Ustilaginales

The smuts. Spore masses are usually black; spores are heavy-walled chlamydospores, germinating by a promycelium (basidium) and four or more sporidia (basidiospores).
Ustilaginaceae. Smuts. Basidiospores are produced on sides of a four-celled promycelium.
Tilletiaceae. Smuts. Elongated basidiospores produced in a cluster at tip of a non-septate promycelium or basidium.

Urediniomycetes

Urediniomycetes – have cylindrical, often slightly curved, transversely septate basidia. Each cell forms a sterigma with a basidiospore, which is forcibly discharged when mature. Usually basidia develop on resting spores spores called teliospores. The Urediniomycetes contain two orders, the Uredinales (rust fungi, obligate parasites on vascular plants) and the Auriculariales.

Uredinales

The rusts. More than 5000 species have been described in about 300 genera. Always parasitic in vascular plants; teliospores or probasidia germinate with a promycelium divided transversely into four cells, each producing a single basidiospore on a sterigma; spore masses are yellowish or orange, and there are several spore forms.
Melampsoraceae. Teliospores sessile, in crusts, cushions, or cylindrical masses, or solitary, or in clusters, in mesophyll or epidermis of host. Now placed in the order Melanosporales.

Pucciniaceae. Teliospores usually stalked, separate, or held together in gelatinous masses; sometimes several on common stalks; less frequently sessile, catenulate, breaking apart.
Auriculariaceae. Basidia with transverse septa; typically gelatinous. The genus *Helicobasidium* causes violet root rot and the genus *Herpobasidium* causes blight of lilac. Now placed in the order Auriculariales.
Septobasidiaceae (Felt fungus). Arid, lichenoid, parasitic on scale insects; probasidia often with thickened walls. Now placed in the order Septobasidiales.
There are six other families, of no particular interest from the standpoint of plant disease.

Basidiomycetes

Basidiomycetes – About 10,000 species have been described and includes the mushrooms and the bracket fungi formed on trees. Most grow in the soil and many form mycorrhiza with roots of forest trees. The hyphae in general are septate and dikaryotic. The septa of the hyphae often have clamp connections, hyphal outgrowths formed during cell division and forming a connection between two cells. The basidia are formed in or on basidiomata on dikaryotic hyphae or on dikaryotic resting spores (teliospores). At maturity they are arranged either in a free, open layer termed hymenium or enclosed in fungal structures termed gleba. The basidiospores are sessile or more often develop on sterigmata. Young basidia are dikaryotic, until the nuclei fuse and meiosis follows. The two, four or more haploid nuclei migrate into the basidiospores, which usually are uni-, occasionally binucleate. Those orders containing plant parasitic species are included below.

Graphioliales

Graphiolaceae. False smuts. Black, erumpent sori and spores in chains; on palms in warmer regions.

Tremellales

Trembling fungi. Basidiocarp usually well developed, often gelatinous varying to waxy or leathery hornlike when dry; mostly saprophytic, sometimes parasitic on mosses, vascular plants, insects, or other fungi.

Agaricales

Hymenium (fruiting layer) present, exposed from beginning or before spores are matured.

Exobasidiaceae. Hymenium on galls or hypertrophied tissues of hosts, which are vascular plants. Martin places this in a separate order, Exobasidiales.

Thelephoraceae. Hymenium smooth or somewhat roughened or corrugated; basidiocarp weblike or membranous, leathery or woody; hymenium on lower side. Now placed in order Aphyllophorales.

Clavariaceae. Hymenium smooth, pileus more or less clavate or club-shaped, erect, simple or branched, fleshy or rarely gelatinous; hymenium on all surfaces. Now placed in order Aphyllophorales.

Hydnaceae. Hymenium covering downward-directed spines, warts, or teeth. Now placed in order Aphyllophorales.

Polyporaceae. Hymenium lining pores (pits or tubes); hymenophore woody, tough or membranous, rarely subfleshy but never soft. Martin places this family and the preceding three in another order, Polyporales. Now placed in order Aphyllophorales.

Boletaceae. Fruiting surface poroid or occasionally pitted; basidiocarp fleshy to tough or membranous.

Agaricaceae. The mushrooms. Fruiting bodies usually fleshy, sometimes tough or membranous, often with a stipe and cap; hymenophore lamellate, with gills.

Hymenogastrales

Hymenium present in early stages, lining chambers of the gleba, closed fruiting body, which is fleshy or waxy, sometimes slimy and fetid at maturity.

Phallales

Gleba slimy and fetid; exposed at maturity on an elongated or enlarged receptacle.

Lycoperdales

The puffballs. Gleba powdery and dry at maturity; spores usually small, pale.

Sclerodermatales

Gleba powdery at maturity; chambers not separating from peridium or each other; spores usually large, dark.

Nidulariales

Bird's nest fungi. Gleba waxy; chamber with distinct walls forming peridioles (the eggs in the nest), which serve as propagules of dissemination.

Deuteromycetes – Fungi Imperfecti (Mycelia Sterilia)

Anamorph fungi are those for which a teleomorph state is not yet known or does not exist. Most of them are in the Ascomycetes. The groupings are based on conidia: hyaline or colored; with one, two, or several cells; formed in pycnidia, on acervuli (little cushions of hyphae breaking through the host epidermis), or free on the surface of the host (see Figs. 2.5 and 2.6).

Sphaeropsidales

Conidia borne in pycnidia or chambered cavities.

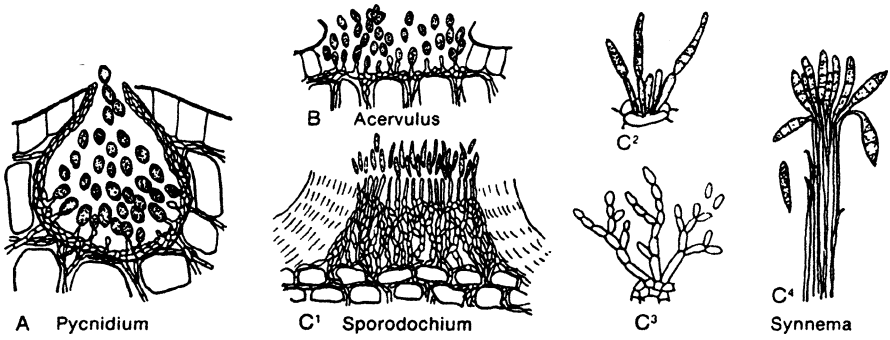

Figure 2.5 Spore formation in the Deuteromycetes. **A** Sphaeropsidales, conidia in pycnidum. **B** Melanconiales, conidia in acervulus. **C** Moniliales – **C**^{1} sporodochium of Tuberculariaceae; **C**^{2} dard conidiophores and conidia of Dematiaceae; **C**^{3} hyaline conidia in chains, Moniliaceae; **C**^{4} conidiophores grouped into a synnema, Stilbaceae

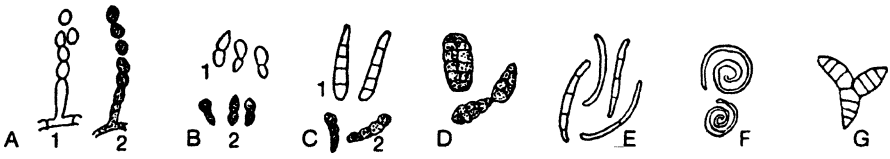

Figure 2.6 Spore forms in the Deuteromycetes, commonly designated by letters and figures. **A** Amerosporae, one-celled; **A**^{1} Hyalosporae, spores hyaline; **A**^{2} Phaeosporae, spores dark. **B** Didymosporae, two-celled; **B**^{1} Hyalodidymae, hyaline; **B**^{2} Phaeodidymae, dark. **C** Phragmosporae, spores with two or more cross septa; **C**^{1} Hyalophragmiae, hyaline or light; **C**^{2} Phaeophragmiae, dark. **D** Dictyosporae, muriform spores. **E** Scolecosporae, filiform spores. **F** Helicosporae, spirally coiled spores. **G** Staurosporae, starlike spores

Sphaerioidaceae (Sphaeropsidaceae Phyllostictaceae). Pycnidia more or less globose, ostiolate or closed; walls dark, tough, leathery or carbonaceous.
Nectrioidaceae. As above but walls or stroma bright-colored, fleshy or waxy.
Leptostromataceae. Pycnidia dimidate (having the outer wall covering only the top half); usually radiate, sometimes long and cleft.
Excipulaceae. Pycnidia discoid or cupulate.

Melanconiales

Conidia borne in definitely circumscribed acervuli; erumpent (breaking through the substratum).
Melanconiaceae. Conidia are slime-spores; cause anthracnose diseases.

Moniliales

Conidiophores (specialized hyphae bearing conidia) superficial, entirely free or bound in tufts or in cushionlike masses (sporodochia).
Pseudosaccharomycetaceae (Cryptococcaceae). False yeasts. Hyphae scanty or nearly lacking; reproduction by budding but not germinating by repetition.
Sporobolomycetaceae. False yeasts. Reproduction by budding and germination by repetition; probably anamorph species of the Tremellales, in the Basidiomycetes.
Moniliaceae. Hyphae and spores hyaline or brightly colored; conidiophores not grouped together.
Dematiaceae. Same as Moniliaceae but hyphae or conidia, or both, brownish to black.
Stilbaceae (Stilbellaceae). Conidiophores united into a coremium or synnema, an upright group of hyphae.
Tuberculariaceae. Hyphae and conidiophores combined in a sporodochium, a tight, spore-bearing mass.

BACTERIA

The fact that bacteria can cause plant diseases was discovered almost simultaneoualy in four different countries, with the United States claiming first honors. In 1878 Professor T. J. Burrill of the University of Illinois advanced the theory that fire blight of apple and pear was due to the bacteria that he found constantly associated with blighted tissues. In 1879, the French scientist Prillieux published a paper on bacteria as the cause of rose-red disease of wheat; in 1880 the Italian Comes recognized bacteria as pathogenic to plants; in 1882 Burrill named his fire-blight organism *Micrococcus amylovorus*; and in 1883 Walker in Holland reported the bacterial nature of yellows disease of hyacinth. It remained, however, for Erwin F. Smith, of the U.S. Department of Agriculture, to do most of the pioneer work in this field and to convince the world that bacteria were to blame for so many diseases. He spent a lifetime in the process, starting with peach yellows, and going on to a study of crown gall and its relation to human cancer. In 1905 the first volume of his monumental work *Bacteria in Relation to Plant Diseases* was published.

There are about 80 species of bacteria which cause plant disease and many of them consisting of numerous pathovars. Bacterial diseases fall into three categories: (1) a wilting, as in cucumber wilt, due to invasion of the vascular system, or water-conducting vessels; (2) necrotic blights, rots, and leaf spots, where the parenchyma tissue is killed, as in fire blight, delphinium black spot, soft rot of iris and other plants with rhizomes or fleshy roots; (3) an overgrowth or hyperplasia, as in crown gall or hairy root.

Pathogenic bacteria apparently cannot enter plants directly through unbroken cuticle but get in through insect or other wounds, through stomata, through hydathodes, possibly through lenticels, and often through flower nectaries. They can survive for some months in an inactive state in plant tissue, as in holdover cankers of fire blight, and perhaps years in the soil, although claims for extreme longevity of the crown-gall organism in soil are discounted.

Most of these plant disease bacteria have had their genus names changed several times since they were first described, and some species have been

combined. Classification of bacteria will probably change further in future years. Where genus and/or species names have been changed, the old name is given in parentheses. The genera and species used in this text agree with those given in Ninth Edition of Bergey's Manual of Determinative Bacteriology (1994) and recent articles in the J. Systematic Bacteriology. Walter H. Burkholder, of Cornell University, who revised the portions of the *Manual* dealing with plant pathogens, followed in the footsteps of Erwin F. Smith by spending his life with bacterial diseases of plants, as did Charlotte Elliott of the U.S. Department of Agriculture, from whose *Manual of Bacterial Plant Pathogens* much information on disease symptoms have been taken.

Two kinds of prokaryotes (organisms that lack a true nucleus) cause disease in plants. Bacteria have a cell membrane, a rigid cell wall, and often one or more flagella. The mollicutes, or phytoplasmas lack a cell wall and have only a single-unit membrane. A general classification of plant pathogenic prokaryotes is shown below:

Kingdom: Prokaryotae – Organisms with genetic material not organized into a nucleus that is not surrounded by a membrane.

Bacteria: Have a cell membrane and cell wall.

Part I: Gram-negative aerobic rods and cocci.

FAMILY: Pseudomonadaceae

GENUS: Pseudomonas, rod-shaped, one or several polar flagella, colonies white.

Xanthomonas, rod-shaped, one polar flagellum, colonies yellow.

Xylella, rod-shaped, under some cultural conditions filamentous; nonmotile, aflagellate, nonpigmented.

Burkholderia, rod-shaped bacteria, motile by one or more polar flagella, colonies white, nutrition very versatile.

Acidovorax, rod-shaped bacteria, motile by single polar flagellum, colonies white, limited number of sugars are used for growth.

Rhizomonas, small rod-shaped bacteria, motile by single polar flagellum, colonies slow growing and white, causes corky root of lettuce.

Rhizobacter, rod-shaped bacterium with one lateral or polar flagellum, colonies white to yellowish-white depending upon the medium, causes carrot bacterial gall.

Ralstonia, rod-shaped bacterium with single polar flagellum, colonies white and usually pleomorphic in shape, causes bacterial wilt in over 200 species of plants.

Xylophilus, rod-shaped bacterium with single polar flagellum, colonies yellow and slow-growing, causes cankers on grape vines.

FAMILY: Rhizobiaceae

GENUS: Agrobacterium, rod-shaped sparse lateral flagella, colonies white, rarely yellow.

Part II: Gram-negative facultative anaerobic rods.

FAMILY: Enterobacteriaceae

GENUS: Erwinia, peritrichous flagella, colonies white or yellow.

Pantoea, peritrichous flagella, colonies yellow. Nutritionally restricted.

Part III: Irregular, Gram-positive, nonsporing rods.

FAMILY: Mycobacteriaceae – The plant pathogens formerly classified into the genus Corynebacterium were separated into the genera: Clavibacter, Curtobacterium, Rhodococcus, Anthrobacter, and Rathoyibacter. Bacteria in all genera are pleomorphic rods and form yellow colonies that are slow growing. Separation of the genera is based primarily on the presence of specific amino acids in the cell walls. Positive identification of the genera is very difficult.

GENUS: Clavibacter. Contains important phyto-pathogenic bacteria formerly classified as Corynebacterium.

Part IV: Actinomycetes, bacteria forming branching filaments.

FAMILY: Streptomycetaceae

GENUS: Streptomyces. Gram-positive, aerial mycelium with chains of nonmotile condidia.

Part V: Mollicutes, prokaryotes that have a cell membrane but no cell wall.

FAMILY: Mycoplasmataceae, the plant mycoplasmalike organisms-phytoplasmas. Spiroplasmataceae.

GENUS: Spiroplasma, helical, motile but lacking flagella.

Phytoplasma, pleomorphic cells not culturable in artificial medium.

The taxonomy of the plant pathogenic fastidious phloem-limited bacteria is still unknown, and the taxonomy of the phytoplasmas, and of the spiroplasmas is tentative. Furthermore, Richettsialike organisms (RLOs) have been reported to be associated with a number of plant diseases. RLOs are also cultured with difficulty which is a characteristic similar to the phytoplasmas. On this basis, both phytoplasmas and RLOs are referred to as 'fastidious prokaryotes'. There are more than 200 distinct plant diseases affecting several hundred genera of plants which have been shown to be caused by the Mollicutes.

The taxonomic scheme for mollicutes and phytoplasmas is difficult to present in this handbook since morphological criteria are limited and both the criteria used in bacteriology and the serological methods used in virology are difficult to apply because phytoplasmas (except for spiroplasma) have not been cultured. Thus the true nature of phytoplasmas and RLOs, and their taxonomic position among microorganisms is uncertain. In practice, the diseases caused by mollicutes have been taxonomically been treated individually. The elucidation of true relatedness among these organisms awaits further research.

The general nature of the symptoms and the name of the host plant will, in many cases, leave little doubt as to the identity of a bacterial disease. In the case of the soft rot due to *Erwinia carotovora* the nose alone is a reliable guide. In other cases identification must be left to the technically trained bacteriologist. It involves special staining technique, for examination of form and motility under the microscope, and to see whether it is Gram-negative or Gram-positive, and special culture technique to determine shape, color, and texture of colonies on agar and gelatin, production of gases, fermentation of sugar, coagulation of milk, etc. If you are in doubt about a plant disease, and the absence of fungus fruiting bodies leads you to believe that bacteria may be at work, send a specimen to your State Experiment Station for expert diagnosis.

VIRUSES, VIROIDS, PHYTOPLASMAS

Viruses

The word virus means poison or venom. When it is used in connection with a plant disease, it means a filterable virus, an infective principle or etiological agent so small it passes through filters that will retain bacteria. Virus diseases in man range from infantile paralysis to the common cold and in plants from "breaking" of tulip flowers to the deadly raspberry ringspot disease on the Malling Jewel variety of raspberry.

Viruses are obligate parasites in that they are capable of increasing only in living cells. They are not organisms in the usual sense because they do not multiply by growth and fission, and they are too complex to be chemical molecules. F. C. Bawden, in the 1964 edition of his *Plant Viruses and Virus Diseases*, defines viruses as "submicroscopic infective entities that multiply only intracellularly and are potentially pathogenic."

Virus diseases are old; our knowledge of them is relatively recent. Tulip mosaic, shown as breaking of flower color, was described in a book published in 1576. In 1892 it was shown that the cause of tobacco mosaic could pass through a bacteria-proof filter, and in 1935 a crystalline protein was prepared from tobacco mosaic virus juice. At present we believe that virus particles contain only two major components, nucleic acid embedded in a protein structure, and that they are built of uniform-sized subunits arranged in a fixed and regular manner. Many plant viruses contain ribonucleic acid (RNA). Some plant viruses and many animal viruses contain deoxyribonucleic acid (DNA) instead of RNA. X-ray diffraction and electron microscopy have shown something of the morphology of virus particles. Some are rods, some filiform, and some are isometric, but polyhedral rather than spherical. They apparently act not as organisms but as disturbances in the host metabolism of nucleic acid.

There are over 850 described plant virus species. Many of the described viruses are definitive members of genera, whose names have been approved by the ICTV (International Committee on Taxonomy of Viruses) to be viruses and could be agents of other kinds. For example, aster yellows and elm phloem necrosis were thought for some time to be caused by viruses, but have now been determined to be caused by phytoplasmas. Moreover, in ►Chap. 4 some phytoplasma may still be positioned under bacterial or viral caused disease since their true identity is not yet known or that the confirmation of identity has been made but missed for inclusion in the 7th edition. In addition, potato spindle tuber and chrysanthemum stunt disease were long thought to be caused by viruses, but have now been determined to be caused by viroids. Viroids consist solely of small RNAs with no protein coat. There are now about 30 plant diseases that have been identified as having viroid causal agents including potato spindle tuber, chrysanthemum stunt, citrus exocortis, chrysanthemum chlorotic mottle, and cadang-cadang of palm. More diseases caused by viroids will probably be identified in future years. There are now about 68 identified phytoplasmas and finally, some plant diseases formerly thought to be caused by viruses have now been determined to be caused by spiroplasma, such as citrus stubborn disease. Thus the field of virology has changed somewhat in recent years. In order to simplify the discussion of these viruses and viruslike agents and the diseases they cause, these agents are grouped under virus diseases, since the symptoms which they cause in plants are similar.

Some viruses attack a large number of different plants and are of great economic importance; others are confined to a single host. Virus symptoms fall into several categories, but commonly there is loss of color due to the suppression of chlorophyll development. Foliage may be mottled green and yellow, mosaic, or have yellow rings (ring spot); or there may be a rather uniform yellowing (yellows). Stunting is common. The reduction in manufactured food from the chlorophyll loss leads to smaller size, shorter internodes, smaller leaves and blossoms, and reduced yield. There may be various distortions of leaves and flowers, witches' brooms, or rosettes. There may be necrotic symptoms with death as the end result, and sometimes symptoms are "masked," not showing up under certain conditions, such as hot weather, or latent, not appearing until another virus is also present.

Viruses are transmitted from plant to plant by: insects, mites, fungi, and nematodes; rubbing, abrasion, or other mechanical means (sometimes handling tobacco and merely touching a healthy plant spreads mosaic); grafting

or propagation by cuttings and bulbs; occasionally seeds; sometimes soil and water; and dodder, parasitic vines whose tendrils link one plant to another. About half of the insect vectors are aphids; a third are leafhoppers. Mealybugs and whiteflies transmit some viruses, and six, including tomato spotted wilt, are transmitted by thrips. In some cases the virus multiples within the insect as well as in the plant. Some viruses have many different vectors, 50 being recorded for onion yellow dwarf, and some have but a single known vector.

Control of virus diseases starts with obtaining healthy seed, cuttings, or plants. "Certified" means that plants have been inspected during the growing season and found free of certain diseases. Virus-free foundation stock can be built up from heat treatment – rowing plants at high temperatures for weeks or even months – and/or meristem tip cultured plants. Virus-free stock is tested by "indexing", bioassays and/or serological assays, before using stock for propagating. Controlling insect vectors (by spraying plants or treating soil with systemic insecticides), eliminating weed hosts, roguing diseased plants before insects can transmit the virus, and using resistant varieties are all ways of combating virus diseases.

This handbook does not deal predominantly with the characteristics of the causal viral agent, but with the disease caused by the virus, viroids and phytoplasmas.

Viruses are classified now in the traditional taxonomic system (family – genus – species). Formal use of a virus species name should be printed in italics with the first word capitalized; an acronym, when used, should also be capitalized. In this book however, we used bold font for the generic name of viruses. Generally, the species name consists of the vernacular plus the generic names. For example, *Tomato spotted wilt tospovirus* is the species name, tomato spotted wilt virus is the vernacular name and *Tospovirus* the generic name. The scheme of virus and viroid classification (shown below) according to Murphy et al. (1995) and Brunt et al. (1996) include the following data: genus of virus, family (if designated), kind of nucleic acid in genome, shape of virions, presence of envelope and the type species:

Alfamovirus

Bromoviridae; (+)ssRNA; isometric particles; not enveloped; alfalfa mosaic virus.

Alphacryptovirus

Partitiviridae; dsRNA; isometric particles; not enveloped; white clover cryptic virus 1.

Badnavirus

dsDNA; bacilliform particles; not enveloped; commelina yellow mottle virus.

Betacryptovirus

Partitiviridae; dsRNA; isometric particles; not enveloped; white clover cryptic virus 2.

Bigeminivirus

Geminiviridae; ssDNA; isometric particles; not enveloped; bean golden mosaic virus.

Bromovirus

Bromoviridae; (+)ssRNA; isometric particles; not enveloped; brome mosaic virus.

Bymovirus

Potyviridae; (+)ssRNA; filamentous particles; not enveloped; barley yellow mosaic virus.

Capillovirus

(+)ssRNA; filamentous particles; not enveloped; apple stem grooving virus.

Carlavirus

(+)ssRNA; filamentous particles; not enveloped; carnation latent virus.

Carmovirus

Tombusviridae; (+)ssRNA; isometric particles; not enveloped; carnation mottle virus.

Caulimovirus

dsDNA; filamentous particles; not enveloped; cauliflower mosaic virus.

Closterovirus

(+)ssRNA; filamentous particles; not enveloped; beet yellows virus.

Comovirus

Comoviridae; (+)ssRNA; isometric particles; not enveloped; cowpea mosaic virus.

Cucumovirus

Bromoviridae; (+)ssRNA; isometric particles; not enveloped; cucumber mosaic virus.

Cytorhabdovirus

Rhabdoviridae; *Mononegavirales*; (-)ssRNA; bacilliform particles; enveloped; lettuce necrotic yellows virus.

Dianthovirus

(+)ssRNA; isometric particles; not enveloped; carnation ringspot virus.

Enamovirus

(+)ssRNA; isometric particles; not enveloped; pea enation mosaic virus.

Fabavirus

Comoviridae; (+)ssRNA; isometric particles; not enveloped; broad bean wilt wirus 1.

Fijivirus

Reoviridae; dsRNA; isometric particles; not enveloped; Fiji disease virus.

Furovirus

(+)ssRNA; rod-shaped particles; not enveloped; soil borne wheat mosaic virus.

Hordeivirus

(+)ssRNA; rod-shaped particles; not enveloped; barley stripe mosaic virus.

Hybrigeminivirus

Geminiviridae; ssDNA; isometric particles; not enveloped; beet curly top virus.

Idaeovirus

(+)ssRNA; isometric particles; not enveloped; raspberry bushy dwarf virus.

Ilarvirus

Bromoviridae; (+)ssRNA; isometric particles; not enveloped; tobacco streak virus.

Ipomovirus

Potyviridae; (+)ssRNA; filamentous particles; not enveloped; sweet potato mild mottle virus.

Luteovirus

(+)ssRNA; isometric particles; not enveloped; barley yellow dwarf virus.

Machlomovirus

(+)ssRNA; isometric particles; not enveloped; maize chlorotic mottle virus.

Macluravirus

(+)ssRNA; filamentous particles; not enveloped; maclura mosaic virus.

Marafivirus

(+)ssRNA; isometric particles; not enveloped; maize rayado fino virus.

Monogeminivirus

Geminiviridae; ssDNA; isometric particles; not enveloped; maize streak virus.

Nanavirus

ssDNA; small isometric particles; not enveloped; subterranean clover stunt virus.

Necrovirus

(+)ssRNA; isometric particles; not enveloped; tobacco necrosis virus.

Nepovirus

Comoviridae; (+)ssRNA; isometric particles; not enveloped; tobacco ringspot virus.

Nucleorhabdovirus

Rhabdoviridae; *Mononegavirales*; (-)ssRNA; bacilliform particles; enveloped; potato yellow dwarf virus.

Oryzavirus

Reoviridae; dsRNA; isometric particles; not enveloped; rice ragged stunt virus.

Ourmiavirus

(+)ssRNA; bacilliform particles; not enveloped; ourmia melon virus.

Phytoreovirus

Reoviridae; dsRNA; isometric particles; not enveloped; wound tumor virus.

Potexvirus

(+)ssRNA; filamentous particles; not enveloped; potato virus X.

Potyvirus

Potyviridae; (+)ssRNA; filamentous particles; not enveloped; potato virus Y.

Rymovirus

Potyviridae; (+)ssRNA; filamentous particles; not enveloped; ryegrass mosaic virus.

Satellivirus

ssRNA or DNA; the satellite viruses depended on helper viruses, but produce their own virions – small isometric; not enveloped; tobacco necrosis virus.

Sequivirus

Sequiviridae; (+)ssRNA; isometric particles; not enveloped; parsnip yellow fleck virus.

Sobemovirus

(+)ssRNA; isometric particles; not enveloped; southern bean mosaic virus.

Tenuivirus

(+/-)ssRNA; thin filamentous particles; not enveloped; rice stripe virus.

Tobamovirus

(+)ssRNA; rod-shaped particles; not enveloped; tobacco mosaic virus.

Tobravirus

(+)ssRNA; rod-shaped particles; not enveloped; tobacco rattle virus.

Tombusvirus

Tombusviridae; (+)ssRNA; isometric particles; not enveloped; tomato bushy stunt virus.

Tospovirus

Bunyaviridae; (-)ssRNA; large isometric particles; enveloped; tomato spotted wilt virus.

Trichovirus

(+)ssRNA; filamentous particles; not enveloped; apple chlorotic leaf spot virus.

Tymovirus

(+)ssRNA; isometric particles; not enveloped; turnip yellow mosaic virus.

Umbravirus

(+)ssRNA; isometric particles; enveloped; carrot mottle virus.

Varicosavirus

dsRNA; rod-shaped particles; not enveloped; lettuce big-vein virus.

Waikavirus

Sequiviridae; (+)ssRNA; isometric particles; not enveloped; rice tungro spherical virus.

Viroids

unencapsidated, small circular ssRNAs. Viroid replication parasitizes plant host transcription. Known described viroids are: apple dimple fruit viroid, apple scar skin viroid, Australian grapevine viroid,. avocado sunblotch viroid, chrysanthemum chlorotic mottle viroid, chrysanthemum stunt viroid, citrus bent leaf viroid, citrus exocortis viroid, citrus III viroid, citrus IV viroid, Coleus blumei 1 viroid, Coleus blumei 2 viroid, Coleus blumei 3 viroid, Columnea latent viroid, coconut cadang-cadang viroid, coconut tinangaja viroid, grapevine yellow speckle 1 viroid, grapevine yellow speckle 2 viroid, hop latent viroid, hop stunt viroid, Iresine viroid 1, Mexicana papita viroid, peach latent mosaic viroid, pear blister canker viroid, potato spindle tuber viroid, tomato apical stunt viroid, tomato planta macho viroid.

Phytoplasma

classification, presented below, based on restriction fragment length polymorphism or putative restriction site analysis of 16s rRNA gene sequences according to Davis and Sinclair (1998).

Aster yellows group: tomato big bud, Michigan aster yellows, clover phyllody, Paulownia witches'-broom, blueberry stunt, apricot chlorotic leafroll, strawberry multiplier.

Peanut witches'-broom group: peanut witch's-broom, witches'-broom of lime – "*Candidatus* Phytoplasma *aurantifolia*", faba bean phyllody, sweet potato little leaf.

X – disease group: X – disease, clover yellow edge, pecan bunch, goldenrod yellows, Spirea stunt, milkweed yellows, walnut witches'-broom, poinsettia branch-inducing, Virginia grapevine yellows.

Coconut lethal yellows group: coconut lethal yellowing, Tanzanian coconut lethal decline.

Elm yellows group: elm yellows, cherry lethal yellows, flavescence doree.

Clover proliferation group: clover proliferation, "Multicipita" phytoplasma.

Ash yellows group: ash yellows.

Loofah witches'-broom group: loofah witches'-broom.

Pigeon pea witches'-broom group: pigeon pea witches'-broom.

Apple proliferation group: apple proliferation, apricot chlorotic leafroll, pear decline, Spartium witches'-broom, black alder witches'-broom.

Rice yellow dwarf group: rice yellow dwarf, sugarcane white leaf, leafhopper-borne.

Stolbur group: stolbur phytoplasma, Australian grapevine yellows – "*Candidatus* Phytoplasma *australiense*".

Mexican periwinkle virescence group: Mexican periwinkle virescence.

Bermudagrass white leaf group: Bermudagrass white leaf.

NEMATODES

In the more then five decades since the first edition of this book was prepared, nematodes have become of major importance in plant pathology. Several hundred species are known to cause plant disease. All plant parasitic nematodes are in the animal kingdom and belong to the phylum Nematoda. Some examples are given after each genus.

PHYLUM: Nematode
ORDER: Tylenchida
SUBORDER: Tylenchina
SUPERFAMILY: Tylenchoidea
FAMILY: Anguinidae
GENUS: *Anguina*, seed gall nematode.
Ditylenchus, stem or bulb nematode of onion, narcissus.
FAMILY: Pratylenchidae
GENUS: *Pratylenchus*, lesion nematode of nearly all plants.
Radopholus, burrowing nematode of citrus.
Naccobus, false root-knot nematode of garden beets, cacti, crucifers, lettuce.
FAMILY: Hoplolaimidae
GENUS: *Hoplolaimus*, lance nematode of corn, turf grass, carnation.
Rotylenchus, spiral nematode of turf grass, tomato, gardenia.
Helicotylenchus, spiral nematode of turf grass, gardenia, azalea, apple, grape.
Rotylenchulus, reniform nematode of turf grass, tomato, gardenia.

FAMILY: Dolichodoridae
GENUS: *Dolichodorns*, and nematode of turfgrass.
FAMILY: Belonolaimidae
GENUS: *Belonolaimus*, sting nematode on wide variety of plants.
Tylenchorhynchus, stunt nematode tobacco, corn
FAMILY: Heteroderidae
GENUS: *Globodera*, cyst nematode of potato.
Heterodera, cyst nematode on wide variety of plants.
Meloidogyne, root-knot nematode on wide variety of plants.
FAMILY: Tylenchidae
GENUS: *Tylenchus*
SUPERFAMILY: Criconematoidea
FAMILY: Criconematidea
GENUS: *Criconemella*, ring nematode of citrus, fig, zoysia.
Hemicycliophora, sheath nematode of beet, bean, blueberry, dracaena.
FAMILY: Tylenchulidae
GENUS: *Tylenchulus*, citrus nematode of citrus, grapes, lilac.
Paratylenchus, pin nematode of carnation, celery, fig.

ORDER: Aphelenchida
SUBORDER: Aphelenchina
SUPERFAMILY: Aphelenchoidea
FAMILY: Aphelenchoididae
GENUS: *Aphelenchoides*, foliar nematode of chrysanthenum, strawberry, lilly, begonia.
Bursaphelenchus, pine wood nematode.
Rhadinaphelenchus, coconut red ring nematode.

ORDER: Dorylaimida
FAMILY: Longidoridae
GENUS: *Longidorus*, needle nematode of grape, celery, leek, lettuce, parsley.
Xiphinema, dagger nematode of rose, trees, many annuals.
ORDER: Triplonchida
FAMILY: Trichodoridae
GENUS: *Paratrichodorus*, stubby root nematode of apple, vegetables.
Trichodorus, stubby root nematode of vegetables, turf grass, dahlia, azalea.

Chapter 3
Plant Diseases and Their Pathogens

Because this is a reference book and not one to be read for pleasure or continuity, most of you will come to the material you need in this section by way of the index or the lists of diseases given under the different hosts in ▶Chap. 4. At the beginning of ▶Chap. 4 you will find a list of headings under which diseases are grouped and described, from Anthracnose to Witchweed. In the Host section, ▶Chap. 4, the key word, for example, rot or blight, is given in capital and small capitals, followed by the name of the pathogen (agent causing disease) in boldface. In this Diseases section, Chap. 3, the pathogens are listed in boldface in alphabetical order under each heading such as ROTS or BLIGHTS and so on, followed by the common name of the disease. This system was adopted for quick and easy reference because trying to alphabetize hundreds of similar common names would lead to endless confusion. Also, it allows a very brief summary of the classification and diagnostic characters of each genus before going on to a consideration of diseases caused by the various species. This brief summary is in small type, so that it can be readily skipped by readers uninterested in the technical details. Perhaps I am the only one who feels the need for this quick review, to be used in conjunction with the classification given in ▶Chap. 2; perhaps others who have to answer questions over a broad field instead of their own specialty can make use of these capsules sandwiched in between nontechnical descriptions.

An alphabetical arrangement has the great disadvantage of being thrown out of alignment every time the name of a fungus is changed, as it so frequently is. In some such cases the old name is retained to avoid change in order, but the present accepted name is also given. Sometimes names have been changed under several hosts and the old name inadvertently retained under others. And sometimes the old name is purposely retained because it is so

familiar to everyone. This is particularly true of a few fungi far better known by their anamorph states than by the correct name of the teleomorph state.
A fungus not only can have several names; it also can cause more than one type of disease. For instance, *Pellicularia filamentosa* is the present name of the fungus formerly known as *Corticium vagum* when causing Rhizoctonia rot of potatoes and *Corticium microsclerotia* when causing web blight of beans. As *Rhizoctonia solani*, the name given to the sclerotial stage, the same fungus causes damping-off of seedlings, root rots of many plants, and brown patch of lawn grasses. There are lots of plant diseases, and there are lots of fungi causing them, but there are not nearly as many separate pathogenic organisms as all the names would indicate. Thus, a Linkage Reference guides the user to two or more common disease sites, i. e. "Canker" or "Blight", where the user searches for the pathogen alphabetically or the link may guide the user directly to a pathogen in another chapter or section.
I cannot think of anything more deadly than ploughing straight through this section from Anthracnose to Wilts. By doctor's orders, take it in small doses, as needed. But do read the few introductory remarks as you look up each group, and please, please, before starting any control measures, read the opening remarks in ► Chap. 1 on Garden Chemicals, and look up, in the list of chemicals, any material you propose to use, noting precautions to be taken along the lines of compatibility, weather relations, and phytotoxicity.
Although the disease descriptions, fungus life cycles, and general principles of control given here will remain fairly valid, it must be stressed that chemicals suggested for control are constantly changing. Today's discovery may be obsolete tomorrow. This *Plant Disease Handbook* should, therefore, be used in conjunction with the latest advice from your own county agent or experiment station. Addresses of the state agricultural experiment stations are given following ► Chap. 4.

ANTHRACNOSE

The term “anthracnose” has been used for two distinct types of disease, one characterized by a typical necrotic spot, a lesion of dead tissue, and the other by some hyperplastic symptom, such as a raised border around a more or less depressed center. The word was coined in France for the latter type, to differentiate a grape disease from a smut of cereals, both of which were called *charbon*. The new word was taken from the Greek *Anthrax* (carbuncle) and *nosos* (disease), and was first used for the grape disease, caused by *Sphaceloma ampelina*, the chief symptom of which was a bird’s-eye spot with a raised border.

A disease of brambles, raspberry and blackberry, was then named anthracnose because it looked like the grape disease. The fungus, however, instead of being correctly placed in the genus *Sphaceloma*, was mistakenly named *Gloeosporium venetum*. The next disease entering the picture was a bean trouble, and, because the fungus was identified as *Gloeosporium* (though later transferred to the genus *Colletotrichum*), this common bean disease with typical necrotic symptoms was also called anthracnose and came to typify diseases so designated.

The term “spot anthracnose” has been given to those diseases similar to the original hyperplastic grape disease. Those with slight hyperplastic symptoms are still commonly called anthracnose, and those with pronounced overgrowth of tissue are commonly called scab. Both types are caused by the genus *Elsinoë*, anamorph state *Sphaceloma*, and are treated, in this revised text, as a separate group. ► Spot Anthracnose.

Anthracnose in the modern sense is a disease characterized by distinctive limited lesions on stem, leaf, or fruit, often accompanied by dieback and usually caused by a *Gloeosporium* or a *Colletotrichum*, anamorph fungi producing slime spores oozing out of fruiting bodies (acervuli) in wet, pinkish pustules. These spores (conidia) on germinating form an appressorium (organ of attachment) before entering the host plant. The teleomorph state of the fungus, when known, is *Gnomonia* or *Glomerella* (see Fig. 3.1).

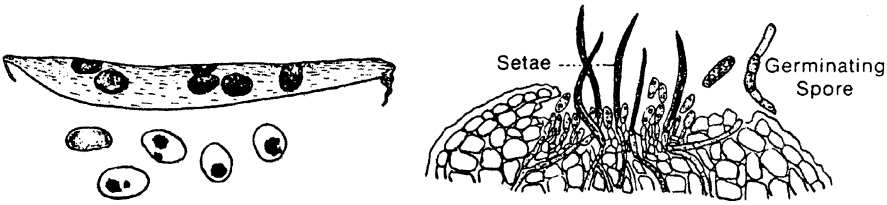

Figure 3.1 Bean Anthracnose. Pod and seeds with dark, sunken areas; section through bean seed showing spores formed in an acervulus marked with prominent black setae

Apiognomonia

Apiognomonia errabunda (Anamorph, *Gloeosporium quercinum*). **Oak Anthracnose**. See *Discula umbrinella* and Fig. 3.2.

Apiognomonia errabunda (formerly *Gnomonia quercina*). **Oak Anthracnose**. The fungus is closely related to *Gnomonia platani*, usually reported as *G. veneta*, but is now considered a separate species. The anthracnose appears as brown areas adjacent to midribs and lateral veins.

Apiognomonia tiliae (formerly *Gnomonia tiliae*). **Linden Anthracnose**, **Leaf Spot**, **Leaf Blotch**, **Scorch** on American and European linden. Small, circular to irregular brown spots with dark margins form blotches along main veins in leaves, leaf stalks, and young twigs, with rose-colored pustules. In wet seasons, defoliation in early summer may be followed by wilting and death of branches. Cut out and burn such branches.

Apiognomonia veneta (formerly *Gnomonia platani*) (*G. veneta*). **Sycamore Anthracnose**, **Twig Blight**, general on American and Oriental planes (London plane is rather resistant) and on California and Arizona sycamores. The fungus winters as mycelium in fallen leaves, producing perithecia that discharge ascospores when young foliage is breaking out. Mycelium also winters in twig cankers. Young sycamore leaves turn brown and die, looking as if hit by late frost. Leaves infected later in the season have irregular brown areas along the veins. Conidia ooze out from acervuli on underside of veins in flesh-colored masses, in rainy weather, and are splashed to other leaves. Twigs and branches have sunken cankers with more acervuli. Native sycamores may be nearly defoliated, with smaller twigs killed. Larger branches die with several successive wet springs. The trees usually put out a second crop of leaves after defoliation, but this is a devitalizing process. Dead twigs and branches give a witches' broom effect to the trees.

Figure 3.2 Oak Anthracnose

On white oaks anthracnose appears as brown areas adjacent to midribs and lateral veins.

Control. Although raking up and burning all fallen leaves has been stressed for years, the overwintering of the fungus on twigs makes this measure rather ineffective. The spray schedule has called for three applications of bordeaux mixture; a dormant spray, one when the buds swell, and another 7 days later. Trees should be fertilized to stimulate vigorous growth.

Colletotrichum

Deuteromycetes, Coleomycetes

Spores are formed in acervuIi, erumpent, cushionlike masses of hyphae bearing conidiophores and one-celled, hyaline, oblong to fusoid conidia. Acervuli have stiff marginal bristles (setae), which are sometimes hard to see. Conidia (slime-spores), held together by a gelantinous coating, appear pinkish in mass. They are not wind-borne but can be disseminated by wind-splashed rain. On landing on a suitable host, the conidium sends out a short germ tube, which, on contact with the epidermis, enlarges at the tip into a brown thick-walled appressorium. From this, a peglike infection hypha penetrates the cuticle.

Colletotrichum acutatum. **Anthracnose** on almond, strawberry and black gum.

Colletotrichum antirrhini. (▸ *Glomerella cingulata*). **Snapdragon Anthracnose**, on snapdragon, chiefly in greenhouses, sometimes outdoors in late summer.

Colletotrichum atramentarium (or *C. coccodes*). **Potato Anthracnose**, **Black Dot Disease** on potato stems and stolons following wilt and other stem diseases, occasionally on tomato, eggplant, and pepper; general distribution but minor importance. Starting below the soil surface, brown dead areas extend up and down the stem. The partial girdling causes vines to lose their fresh color and lower leaves to fall. Infection may extend to stolons and roots. The black dots embedded in epidermal cells, inside hollow stems and on tubers, are sclerotia to carry the fungus over winter and to produce conidia the following spring.

The fungus is a wound parasite ordinarily not serious enough to call for control measures other than cleaning up old refuse and using healthy seed potatoes.

Colletotrichum bletiae (►*Glomerella cingulata*) and other species. **Orchid Anthracnose**, **Leaf Spot** on orchids coming in from the tropics.
Colletotrichum capsici. **Ripe Fruit Rot** of pepper.
Colletotrichum coccodes. **Anthracnose** on soybean.
Colletotrichum dematium (formerly *Colletotrichum omnivorum*). **Anthracnose** on aspidistra and hosta. Large, whitish spots with brown margins are formed on leaves and stalks. Remove and burn infected plant parts.
Colletotrichum dematium. **Anthracnose** on spinach.
Colletotrichum dematium f. sp. **spinaciae**. **Spinach Anthracnose**. Known on spinach since 1880 but unimportant in most years. Leaves have few to many circular spots, water-soaked, turning gray or brown, with setae prominent in spore pustules. The fungus is seed-borne.
Colletotrichum dematium f. sp. **truncata**. **Anthracnose** on tomato. Found in Georgia on *Dolichos*.
Colletotrichum erumpens (►*Glomerella cingulata*). **Rhubarb Anthracnose**, **Stalk Rot**.
Colletotrichum fragariae (►*Glomerella cingulata*). **Strawberry Anthracnose** found in Florida and Louisiana.
Colletotrichum fuscum. **Foxglove Anthracnose** small spots to 1/8 inch, circular to angular, brown to purple brown, on leaves; sunken, fusiform lesions on petioles and veins; minute black acervuli, with bristles, in center of spots. Seedlings damp-off, older plants are killed or stunted in warm moist weather. Use clean seed or treat with hot water (131°F for 15 minutes).
Colletotrichum gloeosporioides (►*Glomerella cingulata*). **Lime Anthracnose**, **Withertip**, only on lime in southern Florida.
Colletotrichum graminicola (formerly *Colletotrichum sublineola*). **Anthracnose** on wild rice (*Zizania*).
Colletotrichum graminicola. **Cereal Anthracnose** widely distributed on barley, oats, rye, wheat, sorghum, wild rice (*Zizamia*) and also on cultivated lawn grasses, causing a root decay and stem rot. Leaf spots are small, circular to elliptical, reddish purple, enlarging and fading with age; centers have black acervuli. The fungus winters on seed and plant refuse in or on soil. Improved soil fertility reduces damage from this disease. This pathogen also causes fruit anthracnose of tomato.
Colletotrichum higginsianum. **Turnip Anthracnose**, also on rutabaga, mustard greens, radish, and Chinese cabbage in southeastern states. Very small, circular gray spots on leaves, and elongate brown or gray spots on midrib, petiole, and stem, show pink pustules in centers of dead tissue. Heav-

ily infected leaves turn yellow and die; young seeds in diseased pods may be killed. Mustard variety Southern Curled Giant is highly resistant.

Colletotrichum lagenarium (see *Colletotrichum orbiculare*). **Melon Anthracnose** on muskmelon, watermelon, cucumber, and other cucurbits.

Colletotrichum liliacearum (see *Colletotrichum lilii*). Found on dead stems of daylilies and many other plants and perhaps weakly parasitic.

Colletotrichum lilii (formerly *Colletotrichum liliacearum*). Found on dead stems of daylilies and many other plants and perhaps weakly parasitic.

Colletotrichum lindemuthianum (▶ *Glomerella lindemuthianum*). **Bean Anthracnose**, a major bean disease, sometimes mistakenly called "rust," generally present in eastern and central states, rare from the Rocky Mountains to the Pacific Coast.

Colletotrichum malvarum. **Hollyhock Anthracnose**, **Seedling Blight** on hollyhock, mallow, and abutilon, particularly destructive to greenhouse seedlings. Black blotches are formed on veins, leaf blades, petioles, and stems. Remove and burn all old plant parts in autumn.

Colletotrichum omnivorum (see *Colletotrichum dematium*). **Anthracnose** on aspidistra and hosta. Large, whitish spots with brown margins are formed on leaves and stalks. Remove and burn infected plant parts.

Colletotrichum orbiculare. **Anthracnose** on watermelon.

Colletotrichum orbiculare (formerly *Colletotrichum lagenarium*). **Melon Anthracnose** on muskmelon, watermelon, cucumber, and other cucurbits. This is our most destructive disease of watermelons, found everywhere that melons are grown and particularly destructive in the South. There are at least three races of the fungus differing in ability to infect different cucurbits. One race is virulent on cucumber, slight on watermelon, moderate on Butternut squash; another is virulent on both watermelon and cucumber; Butternut squash is immune to a third.

Leaf symptoms are small yellow or water-soaked areas, which enlarge and turn black on watermelon, brown on muskmelon and cucumber. The dead tissue shatters; leaves shrivel and die. Elongated, narrow, sunken lesions appear on stems and petioles; vines may die. Young fruit darkens, shrivels and dies if pedicels are infected; older fruit shows circular, black, sunken cankers or depressions, from 1/4 to 2 inches across and 1/3 inch deep on watermelon. In moist weather the centers of such spots are covered with gelatinous masses of salmon-colored spores. Infected fruit has a bitter taste or the flesh is tough and insipid. Soft rots often follow the anthracnose. Epiphytotics occur only in periods of high rainfall and temperature, near 75°F.

Control. Treating seed before planting is essential. Use a three year crop rotation with non-cucurbits; destroy plant refuse. Watermelon varieties Charleston Gray, Congo, Fairfax, and Black Kleckly are resistant but not to all races of the fungus.

Colletotrichum phomoides (►*Glomerella cingulata*).**Tomato Anthracnose**, common rot of ripe tomatoes, most frequent in Northeast and North Central districts. Symptoms appear late in the season, causing more loss to canning crops. Small, circular sunken spots, increasing to an inch in diameter, penetrate deeply into the flesh. At first water-soaked, the spots turn dark, with pinkish, cream, or brown spore masses in the depressed centers, often arranged in concentric rings. The disease is worse in warm, moist weather. The fungus winters in tomato refuse, sometimes in cucumber and melon debris.

Control. Clean up trash and rotting fruit.

Colletotrichum pisi (►*Glomerella cingulata*). **Pea Anthracnose**, **Leaf and Pod Spot** commonly associated with Ascochyta blight and often a secondary parasite.

Colletotrichum schizanthi. **Anthracnose** on butterfly-flower. Symptoms are small brown spots on leaves and water-soaked areas on young stems. Cankers on stems and branches of older plants may cause leaves to turn yellow, branches to die back from the tip, and finally death of all parts above the canker.

Colletotrichum sublineola (see *Colletotrichum graminicola*). **Anthracnose** on wild rice (*Zizania*).

Colletotrichum trichellum. **Fruit Anthracnose** of tomato and Hedera.

Colletotrichum truncatum. **Stem Anthracnose** prevalent in the South on bean, lima bean, and soybean, also on clovers and on lentil in ND. Brick-red spots appear on veins on underside of leaves and on pods. Plants are chlorotic, stunted, may die prematurely; blossoms or pods may drop. Use healthy seed grown in arid states; clean up plant refuse; rotate with non-legumes.

Colletotrichum violae-tricoloris (►*Glomerella cingulata*). **Anthracnose** of violet, pansy.

Colletotrichum sp. **Azalea Anthracnose**. New disease serious on Indian and Kurume azaleas in Louisiana since 1954. Very small rusty brown spots appear on both surfaces of young leaves, followed by defoliation. Spores appear on fallen leaves, which serve as source of inoculum for the next season. Copper and organic fungicides are effective in control.

Discula

▶ Blights.

Discula campestris. **Anthracnose** on maple.
Discula destructive. **Anthracnose** on dogwood.
Discula fraxinea. (Teleomorph, **Gnomoniella fraxini**). **Anthracnose** on ash.

Gloeosporium

Deuteromycetes, Coleomycetes

Genus characters are about the same as for *Colletotrichum* except that there are no setae around the acervuli. Conidia are hyaline, one-celled, appearing in masses or pustules on leaves or fruit. Leaf spots are usually light brown, with foliage appearing scorched.

Gloeosporium allantosporum (▶ *Phlyctema vagabunda*). **Anthracnose**, **Dieback** on raspberry in Oregon, Washington.
Gloeosporium apocryptum (▶ *Glomerella cingulata*). **Maple Anthracnose**, **Leaf Blight**, an important leaf disease of silver maple, common also on other maples and boxelder, appearing from late May to August.
Gloeosporium aridum (**Discula fraxinea**). **Anthracnose** on ash.
Gloeosporium limetticolum (▶ *Glomerella cingulata*). **Lime Anthracnose**, **Withertip**, only on lime in southern Florida.
Gloeosporium melongenae (▶ *Glomerella cingulata*). (possibly identical with *G. piperatum*). **Eggplant Anthracnose**, **Ripe Rot**, an occasional trouble.
Gloeosporium piperatum (▶ *Glomerella cingulata*). **Pepper Anthracnose**, **Fruit Spot**, sometimes a leaf and stem spot but more often a disease of green or ripe fruit.
Gloeosporium quercinum (Telemorph, ▶ *Apiognomonia errabunda*). **Oak Anthracnose**. See *Discula umbrinella* and Fig. 3.2.
Gloeosporium thuemenii f. sp. **tulipi**. **Tulip Anthracnose** found in California in 1939. Lesions on peduncles and leaf blades of Darwin tulips are small to large, elliptical, first water-soaked then dry with black margins and numerous black acervuli in center of spots.
Gloeosporium sp.**Peony Anthracnose** on stems, leaves, flowers, petals of peony. Stem lesions are sunken, with pink spore pustules, and may complete-

ly girdle the stalks, causing death of plants. Also a destructive anthracnose on strawberry.

Glomerella

Ascomycetes, Phyllachorales

Perithecia are dark, hard, carbonaceous, usually beaked, immersed in substratum so only the neck protudes. Ascospores are hyaline, one-celled; asci are thickened at tips, inoperculate but spores sometimes discharged with force; paraphyses present.

Glomerella cingulata (formerly *Colletotrichum violae-tricoloris*). **Anthracnose** of violet, pansy. Circular dead spots with black margins, sometimes zonate, appear on leaves; flowers have petals spotted or not fully developed and producing no seed; entire plants are sometimes killed. Remove and burn infected plants or parts; clean up old leaves in fall. Copper sprays may be injurious.

Glomerella cingulata (formerly *Colletotrichum gloeosporioides*). **Anthracnose**, **Canker**, **Dieback**, **Withertip**, **Fruit Rot** of a great many plants, generally distributed except on the Pacific Coast, more common in the South. Infection is often secondary, in tissues weakened from other causes. See also under Canker and under Rots.

On citrus, orange, lemon, grapefruit there is a dying back or withertip of twigs. Leaf spots are light green turning brown, with pinkish spore pustules prominent in wet weather. Decayed spots are produced on ripening fruits in storage. Similar withertip symptoms may also appear on avocado, aucuba, cherimoya, fig, loquat, roselle, rosemallow, royal palm, dieffenbachia, rubber-plant, strawberry and other ornamentals and fruits. The disease has also been reported on European white birch in Virginia. Lack of water and nutrient deficiency predispose plants to infection by this weak parasite.

The fungus attacks blue lupine and statice or sea-lavender; peach anthracnose became important in Georgia when lupine was used as a ground cover in orchards. Sweet pea anthracnose is often more severe near apple orchards where the fungus winters on cankered apple limbs and in bitter rot mummies. Whitish lesions disfigure sweet pea leaves, shoots, and flower stalks. Leaves wither and fall; stalks dry up before blossoming; seed pods shrivel. There may be general wilting and shoot dieback.

Anthracnose and twig blight are widespread on privet. Leaves dry and cling to the stem; cankers at the base of stems are dotted with pink pustules. Bark

turns brown and splits; death follows complete girdling of stems. European privet is highly susceptible; California, Amur, Ibota, and Regal privets are fairly resistant. Also found on black locust in GA and SC and pecan in GA.

Control. Remove infected twigs and branches from trees and shrubs, taking care to make smooth cuts at base of limbs and painting surfaces with a wound dressing. Plant sweet peas, from healthy pods, at a distance from apple and privet, in clean soil; rake up and burn plant refuse at the end of the season.

Glomerella cingulata (formerly *Gloeosporium melongenae*). (possibly identical with *G. piperatum*). **Eggplant Anthracnose Ripe Rot**, an occasional trouble. Yellow to brown spots on leaves and small to medium depressed spots on fruit show pink spore masses following rain or heavy dew. Spores are splashed by rain and spread by tools, insects, and workmen. Rotation of crops and sanitary measures may be sufficient control.

Glomerella cingulata (formerly *Gloeosporium limetticolum*). **Lime Anthracnose Withertip**, only on lime in southern Florida. Shoots, leaves, and fruits are infected when young; mature tissues are immune. Twigs wither and shrivel from one inch to several inches back from the tip; young leaves have dead areas or are distorted; buds fail to open and may drop; fruits drop, or are misshapen, or have shallow spots or depressed cankers.

Control. Spray with bordeaux-oil emulsion as fruit is setting, with two or three applications of 1 to 40 lime sulfur at 7–14 day intervals.

Glomerella cingulata (formerly *Gloeosporium apocryptum*). **Maple Anthracnose Leaf Blight**, an important leaf disease of silver maple, common also on other maples and boxelder, appearing from late May to August. The leaf spots are light brown, often merging with the leaves, appearing scorched. The effect may be confused with the physiological scorch caused by hot weather. On Norway maples the leaf lesions are confined to purple to brown lines along the veins. In rainy seasons there may be severe defoliation.

Control. If trees have been affected more than a year or so, feed to stimulate vigorous growth. Spray with a copper fungicide two or three times at 14-day intervals, starting when buds break open.

Glomerella cingulata (formerly *Colletotrichum bletiae*) and other species. **Orchid Anthracnose Leaf Spot** on orchids coming in from the tropics. Lemon-colored acervuli are formed in soft, blackish spots in ragged leaves. Burn diseased plants or parts. Spray with a copper fungicide.

Glomerella cingulata (formerly *Colletotrichum pisi*). **Pea Anthracnose Leaf and Pod Spot** commonly associated with Ascochyta blight and often

a secondary parasite. Spots on pods, stems, and leaves are sunken, gray, circular, with dark borders. Crop rotation is the best control.

Glomerella cingulata (formerly *Gloeosporium piperatum*). **Pepper Anthracnose**, **Fruit Spot**, sometimes a leaf and stem spot but more often a disease of green or ripe fruit. Spots are dark, sunken, with concentric rings of acervuli and pink masses of spores, which are washed to other fruit. Seed is infected internally and contaminated externally. Harvest seed only from healthy fruit.

Glomerella cingulata (formerly *Colletotrichum erumpens*). **Rhubarb Anthracnose**, **Stalk Rot**. Oval, soft watery spots on petioles increase until whole stalks are included; leaves wilt and die. Small dark fruiting bodies with setae survive winter in stems, produce conidia in spring. Clean up all rhubarb remains in fall.

Glomerella cingulata (formerly *Colletotrichum antirrhini*). **Snapdragon Anthracnose** on snapdragon, chiefly in greenhouses, sometimes outdoors in late summer. Stems have oval, sunken spots, grayish white with narrow brown or reddish borders, fruiting bodies showing as minute black dots in center. Spots on leaves are circular, yellow green turning dirty white, with narrow brown borders. Stem cankers may coalesce to girdle plant at base, causing collapse of upper portions, with leaves hanging limp along the stem.

Control. Take cuttings from healthy plants; provide air circulation; keep foliage dry; destroy infected outdoor plants in autumn. Spray, every 7 to 10 days.

Glomerella cingulata (formerly *Colletotrichum phomoides*). **Tomato Anthracnose**, common rot of ripe tomatoes, most frequent in Northeast and North Central districts. Symptoms appear late in the season, causing more loss to canning crops. Small, circular sunken spots, increasing to an inch in diameter, penetrate deeply into the flesh. At first water-soaked, the spots turn dark, with pinkish, cream, or brown spore masses in the depressed centers, often arranged in concentric rings. The disease is worse in warm, moist weather. The fungus winters in tomato refuse, sometimes in cucumber and melon debris.

Control. Clean up trash and rotting fruit.

Glomerella glycines, **Fruit Anthracnose** of tomato. Also, anthracnose on soybean.

Glomerella gossypii, **Fruit Anthracnose** of tomato. Also, anthracnose on cotton.

Glomerella lindemuthianum (formerly *Colletotrichum lindemuthianum*). **Bean Anthracnose**, a major bean disease, sometimes mistakenly called "rust," generally present in eastern and central states, rare from the Rocky Mountains to the Pacific Coast. It may also affect lima bean, Scarlet runner, tepary, mung, kudzu, and broad beans, and cowpea. It is worldwide in distribution, known in the United States since 1880. There are at least 34 strains of the fungus, in three different groups, but the disease has decreased in importance with the use of western-grown, anthracnose-free seed.

The most conspicuous symptoms are on the pods, small, brown specks enlarging to black, circular, sunken spots, in moist weather showing the typical pinkish ooze of the slime-spores. Older spots often have narrow reddish borders. After the spores are washed away, the acervuli look like dark pimples. If pods are infected when young, the disease extends through to the seed, which turns yellow, then rusty brown or black under the pod lesion. The infection may extend deep enough to reach the cotyledons. Leaf lesions are dark areas along veins on underside of the blade and on petioles. Seedlings may show stem spotting below diseased cotyledons. The fungus is spread by splashing rain, tools, and gardeners working with beans when they are wet. Optimum temperature is between 63° and 75°F, with maximum around 85°F.

Control. Use western-grown seed. Saving home-grown seed is dangerous unless you can be sure of selecting from healthy plants and pods. Clean up, or spade under, old bean tops; rotate crops. Never pick or cultivate beans when vines are wet. There are some resistant varieties, but more reliance should be placed on obtaining seed grown where the disease is not present.

Glomerella nephrolepidis. **Fern Anthracnose**, **Tip Blight** of Boston and sword ferns. The soft growing tips of fronds turn brown and dry. Keep foliage dry; remove and burn diseased leaves.

Gnomonia

Ascomycetes, Diaporthales

Perithecia innate, beaked, separate; paraphyses absent; ascospores two-celled, hyaline; anamorph state *Gloeosporium* or *Marssonina*. Diseases caused by *Gnomonia* are classified as anthracnose, scorch, or leaf spot.

Gnomonia caryae. **Hickory Anthracnose**, **Leaf Spot**, widespread. The disease is common in eastern states, causing defoliation in wet seasons.

Large, roundish spots are reddish brown on upper leaf surface, dull brown underneath. The fruiting bodies are minute brown specks, and the fungus winters in dead leaves on the ground.

Gnomonia leptostyla (*Marssonina juglandis*). **Walnut Anthracnose, Leaf Spot**, general on butternut, hickory, and walnut. Spring infection comes from ascospores shot from dead leaves on the ground, secondary infection from conidia. Irregular dark brown spots appear on leaflets in early summer; if these are numerous, there is defoliation. An unthrifty condition of black walnuts and butternuts is often due to anthracnose.

Microdochium

Deuteromycetes, Coelomycetes

Hyaline, two-celled spores are formed in acervuli without setae. Spores are rounded at ends and are formed in pale to black masses on leaves.

Microdochium panattonianum (formerly *Marssonina panattoniana*). **Lettuce Anthracnose**. Small, dead, brown spots appear on blades and petioles, centers often falling out leaving black margined shot holes. Spots progress from older to young inner leaves; outer leaves are broken off and blown around by wind. The disease is important only during prolonged periods of wet weather, when it may cause heavy losses. Sanitary measures and treating seed before planting suffice for control.

Monographella

Ascomycetes, Dothideales

Perithecia immersed in substratum, not beaked, not setose, paraphyses lacking; spores hyaline, two-celled. The genus contains more than 1000 species, many destructive to plants, with conidial stages in many genera.

Monographella opuntiae (formerly *Mycosphaerella opuntiae*). **Cactus Anthracnose** on Cereus, Echinocactus, Mammillaria, and Opuntia. The curved spores of the anamorph state (*Microdochium lunatum*) form light pink pustules on the surface of moist, light brown rotten areas. Cut out and destroy diseased segments.

Pezicula

Ascomycetes, Helotiales

This is one of the discomycetes, cup fungi. The apothecia, formed on living plants, are fleshy, bright-colored with a peridium of dark cells forming a pseudoparenchyma. Spores are hyaline, fusoid.

Pezicula malicorticis (formerly *Neofabraea malicorticis*). **Northwestern Apple Anthracnose** on apple, crabapple, pear, quince, chiefly in the Pacific Northwest, where it is a native disease, serious in regions with heavy rainfall. Cankers are formed on younger branches – elliptical, dark, sunken, up to 3 or 4 inches wide and 10 to 12 inches long, delimited when mature by a crack in the bark. Conidia of the anamorph state (*Gloeosporium malicorticis*) are formed in cream-colored cushions, which turn black with age, in slits in the bark. Young cankers, reddish brown, circular spots appear on the bark in late fall. Fruit is infected, usually through lenticels from either ascospores or conidia in pustules on bark, but the disease may not show up until the apples are in storage.
Control. Cut out diseased limbs or excise cankers, burning all prunings and dead bark. Spray with bordeaux mixture before fruit is picked and fall rains start; repeat after harvest, and again about 2 weeks later.

Phlyctema

Deuteromycetes, Coleomycetes

Pycnidia dark, separate or sometimes cofluent, developing in or under the epidermis or bark. Conidiophores simle or forked; conidia hyaline, 1-celled, cylindrical or log, spindle-shapped, mostly bent.

Phlyctema vagabunda (formerly *Gloeosporium allantosporum*). **Anthracnose**, **Dieback** on raspberry in Oregon, Washington. See *Elsinoë veneta* under Spot Anthracnose for the common raspberry disease called anthracnose.

Pseudopeziza

Ascomycetes, Helotiales

Apothecia brown, cup-shaped, arising from leaves on short stalks, not setose, paraphyses present; spores one-celled, hyaline, ovoid.

Drepanopeziza ribis (formerly *Pseudopeziza ribis*). **Current Anthracnose, Leaf, Stem and Fruit Spot** generally distributed on currant, flowering currant, and gooseberry, first reported on black currants in Connecticut in 1873. Very small, brown, circular spots appear first on lower, older leaves, which turn yellow if spots are numerous. Hyaline, crescent-shaped conidia are formed in moist, flesh-colored masses in center of spots. In severe infections there is progressive defoliation from below upward.

Other occasional symptoms are black, sunken spots on leaf stalks, light brown to pale yellow lesions on canes, and black flyspeck spots on green berries, with considerable reduction in yield. Apothecia are formed on fallen leaves; ascospores are forcibly discharged in spring and carried by wind to young leaves.

Control. Clean up and burn old leaves under the bushes. Spray with bordeaux mixture (preferred to the newer organics) shortly after leaves appear (about 3 weeks after blossoming) and immediately after picking. Include a good spreader and cover both leaf surfaces thoroughly.

Pseudopeziza ribis (see *Drepanopeziza ribis*). **Current Anthracnose, Leaf, Stem and Fruit Spot** generally distributed on currant, flowering currant, and gooseberry, first reported on black currants in Connecticut in 1873.

BACTERIAL DISEASES

Rhizobiaceae

Agrobacterium

Small, motile, short rods, with two to six peritrichous flagella or a polar or subpolar flagellum, ordinarily Gram-negative, not producing visible gas or detectable acid in ordinary culture media; growth on carbohydrate media usually accompanied by copious entracellular, polysaccharide slime; gelatin liquefied slowly or not at all; optimum temperatures 25° to 30°C. Found in soil, or plant roots in soil, or in hypertrophies or galls on roots or stems of plants.

Agrobacterium rhizogenes. Hairy Root of apple, also recorded on cotoneaster, hollyhock, honey locust, honeysuckle, mulberry, peavine, peach, quince, Russian olive, rose, and spirea. "Woolly root" and "woolly knot" are other names given to this disease, which was long considered merely a form of crown gall. Both diseases may appear on the same plant and in early stages be confused. In hairy root a great number of small roots protrude either directly from stems or roots or from localized hard swellings that frequently occur at the graft union. The disease is common on grafted nursery apple trees 1, 2, or 3 years old, and the root development may be as profuse as witches' brooms. Control measures are the same as for crown gall.

Agrobacterium rubi. Cane Gall of brambles, on blackberry, black and purple raspberries, and, very rarely, red raspberry. Symptoms appear on fruiting canes in late May or June as small, spherical protuberances or elongated ridges of white gall tissue, turning brown after several weeks. Canes often split open and dry out; produce small seedy berries. Cane gall is not as important as crown gall, but one should use the same preventive measures. Avoid runner plants from infected mother plants.

Agrobacterium tumefaciens. Crown Gall on a great variety of plants in more than 40 families, general on blackberry, raspberry, and other brambles,

Figure 3.3 Crown Gall on Rose

on grapes and on rose (see Fig. 3.3); on fruit trees – apple, apricot, cherry, fig, peach and nectarine, pear (rarely), plum; on nuts – almond very susceptible, walnut fairly susceptible, pecan occasionally; on shade trees, willow and other hard woods; rare on conifers but reported on incense cedar and juniper; on many shrubs and vines, particularly honeysuckle and euonymus; on perennials such as asters, daisies, and chrysanthemums; and on beets, turnips, and a few other vegetables, with tomato widely used in experiments. Crown gall was first noticed on grape in Europe in 1853, and the organism was first isolated in 1904 in the United States from galls on Paris daisy. It

is of first importance as a disease of nursery stock, but may cause losses of large productive trees in neglected orchards, especially almonds and peaches in California and other warm climates. It is very important to rose growers and to the amateur gardeners who sometimes receive infected bushes.

Symptoms. The galls are usually rounded, with an irregular rough surface, ranging up to several inches, usually occurring near the soil line, commonly at the graft union, but sometimes on roots or aerial parts. On euonymus, galls are formed anywhere along the vine. This is primarily a disease of the parenchyma, starting with a rapid proliferation of cells in the meristematic tissue and the formation of more or less convoluted soft or hard overgrowths or tumors. The close analogy of the unorganized cell growth of plant galls to wild cell proliferation in human cancer has intrigued scientists for many years. In some fashion bacteria provide stimulus for this overdevelopment, but similar galls have been produced on plants experimentally by injecting a virus or growth-promoting substances.

Entrance of bacteria into plants for natural infection is through wounds. In nurseries and orchards nematodes, the plow, the disc, or the hoe may be responsible; on the propagating bench grafting tools are indicted. Many claims have been made for the longevity of crown gall bacteria in soil, but it now seems to be established that they do not live in the absence of host plants more than a couple of years, and that sudden outbreaks of crown gall on land not previously growing susceptible crops are due to irrigation water bringing in viable bacteria from other infected orchards. The addition of lime to the soil may encourage crown gall, for bacteria do not live in an acid medium. The period of greatest activity is during the warm months.

Control. For home gardens rigid exclusion of all suspected planting stock is the very best control. Do not accept from your nurseryman blackberries, raspberries, roses, or fruit trees showing suspicious bumps. If you have had previous trouble, choose a different location for new, healthy plants. Be careful not to wound stems in cultivating.

For nurserymen, sanitary propagating practices are a must. Stock should be healthy. Grafting knives should be sterilized by frequent dipping in 10% Chlorox solution, 1 ounce in 2 gallons of water, or in denatured alcohol. If nursery soil is infested, 2 years' growth of cowpeas, oats, or crotalaria between crops will minimize crown gall.

Fruit and nut growers can perhaps plant less susceptible varieties, although fruit that is resistant in one locality may be diseased in another. American grape varieties are considered more resistant than European. Apples may be

better on mahaleb root-stock, nut trees on black walnut understock. Budding rather than grafting reduces the chance of infection.
Painting galls with a solution of Elgetol-methanol has given control of crown gall on peaches and almonds in California. One part Elgetol (sodium dinitrocresol) is shaken with 4 parts synthetic wood alcohol and applied with a brush, covering the surface of the gall and extending 1/2 inch to 1 inch beyond the margin into healthy bark.

Coryneform Group Mycobacteriaceae

Clavibacter

Slender, straight to slightly curved rods, with irregularly stained segments or granules, often with pointed or club-shaped swellings at ends; nonmotile with a few exceptions (*C. flaccumfaciens* and *C. poinsettiae*). Gram-positive.

Clavibacter agcopyri (see *Corynebacterium agcopyei*). **Yellow Gum Disease** on western wheat grass.
Clavibacter fascians (see *Rhodococcus fascians*). **Fasciation**, widespread on sweet pea, also on carnation, chrysanthemum, gypsophila, geranium, petunia,impatiens, *Hebe* sp. and pyrethrum.
Clavibacter flaccumfaciens (see *Curtobacterium flaccumfaciens* pv. *flaccumfaciens*). **Bacterial Wilt** of bean, widespread on kidney and lima beans and soybean, causing considerable loss.
Clavibacter humiferum (see *Corynebacterium humiferum*). Reported from wetwood of poplar, in Colorado.
Clavibacter michiganense (see *Clavibacter michiganense* subsp. *michiganense*). **Bacterial Canker** of Tomato, widespread, formerly causing serious losses of tomato canning crops.
Clavibacter michiganense subsp. **michiganense** (formerly *Clavibacter michiganens*). **Bacterial Canker** of Tomato, widespread, formerly causing serious losses of tomato canning crops. The disease has now been reported on browallia, brunfelsia, cestrum, *Datura* sp., eggplant, Jerusalem-cherry, bittersweet, pepper, painted-tongue, potato, ground-cherry, and butterfly-flower in Wyoming. This is a vascular wilt disease, seedlings remaining stunted. Symptoms on older plants start with wilting of margins of lower leaflets, often only on one side of a leaf. Leaflets curl upward, brown, and wither, but remain attached to stem. One-sided infection may extend up through the plant and open cankers from pith to outer surface of stem. Fruit infection starts with small, raised, snow-white spots, centers later browned

and roughened but the white color persisting as a halo to give a bird's-eye spot. Fruits can be distorted, stunted, yellow inside. In the field, bacteria are spread by splashed rain and can persist in soil 2 or more years. Seeds carry the bacteria internally as well as externally.

Control. Use certified seed, a 2- or 3-year rotation; clean up tomato refuse at end of season and diseased plants throughout season. Fermenting tomato pulp for 4 days at a temperature near 70°F will destroy bacteria on surface of seed; hot-water treatment, 25 minutes at 122°F will kill some, perhaps not all, of internal bacteria. Start seedlings in soil that has not previously grown tomato.

Clavibacter poinsettiae (see *Curtobacterium flaccumfaciens* pv. *poinsettia*). **Stem Canker** and **Leaf Spot** of Poinsettia, a relatively new disease, first noted in greenhouses in 1941.

Clavibacter sepedonicum (see *Clavibacter michiganense* subsp. *sepedonicum*). **Bacterial Ring Rot** of potato, widespread since 1931, when it probably was introduced from Europe.

Clavibacter michiganense subsp. sepedonicum (formerly *Clavibacter sepedonicum*). **Bacterial Ring Rot** of potato, widespread since 1931, when it probably was introduced from Europe. All commercial varieties are susceptible, with losses formerly in millions of dollars in decay of tubers in field and storage. Now a single infected plant in a potato field disqualifies the whole field for certification. Symptoms appear when plants are nearly full grown, with one or more stems in a hill wilted and stunted while the rest seem healthy. Lower leaves have pale yellow areas between veins; these turn deeper yellow, and margins roll upward. A creamy exudate is expelled when the stem is cut across. This bacterium may also occur in sugar beet which are symptomless.

Tuber infection takes place at the stem end, and the most prominent symptoms appear some time after storage. The vascular ring turns creamy yellow to light brown, with a crumbly or cheesy odorless decay followed by decay from secondary organisms. Bacteria are not spread from plant to plant in the field, but by cutting knife and fingers at planting. A knife used to cut one infected tuber may contaminate the next 20 seed pieces.

Control. Use certified seed potatoes. Use several knives and rotate them in disinfestant. Commercial growers use a rotating knife passed through a chemical or hot-water bath between cuts. Disinfest tools, grader, digger, and bags; sweep storage house clean and spray with copper sulfate, 1 pound to 5 gallons of water.

Clavibacter xyli subsp. **cynodontis**. **Stunting Disease** of bermudagrass.
Clavibacter xyli subsp. **xyli**. **Ratoon Stunt** of sugarcane.
Corynebacterium agropyri (formerly *Clavibacter agropyri*). **Yellow Gum Disease** on western wheat grass. Enormous masses of surface bacteria form yellow slime between stem and upper sheath and glumes of flower head; plants dwarfed or bent; normal seeds rare.
Corynebacterium humiferum (formerly *Clavibacter humiferum*). Reported from wetwood of poplar, in Colorado.
Curtobacterium flaccumfaciens pv. flaccumfaciens (formerly *Clavibacter flaccumfaciens*). **Bacterial Wilt of Bean**, widespread on kidney and lima beans and soybean, causing considerable loss. Plants wilt at any stage from seedling to pod-production, with leaves turning dry, brown, and ragged after rains. Plants are often stunted. Bacteria winter on or in seed, which appear yellow or wrinkled and varnished. When infected seed is planted, bacteria pass from cotyledons into stems and xylem vessels. Other plants are infected by mechanical injury and perhaps by insects, but there is not much danger from splashed rain. Plants girdled at nodes may break over.
Control. Use seed grown in Idaho or California.
Curtobacterium flaccumfaciens pv. poinsettia (formerly *Clavibacter poinsettiae*). **Stem Canker** and **Leaf Spot** of Poinsettia, a relatively new disease, first noted in greenhouses in 1941. Longitudinal water-soaked streaks appear on one side of green stems, sometimes continuing through leaf petioles to cause spotting or blotching of leaves and complete defoliation. The cortex of stems turns yellow, the vascular system brown. Stems may crack open and bend down, with glistening, golden brown masses of bacteria oozing from stem ruptures and leaf lesions.
Control. Discard diseased stock plants; place cuttings from healthy mother plants in sterilized media; avoid overhead watering and syringing; rogue suspicious plants promptly.
Rhodococcus fascians (formerly *Clavibacter fascians*). **Fasciation**, widespread on sweet pea, also on carnation, chrysanthemum, gypsophila, geranium, petunia,impatiens, *Hebe* sp. and pyrethrum. Sweet pea symptoms are masses of short, thick, and aborted stems with misshapen leaves developing near the soil line at first or second stem nodes. The fasciated growth on old plants may have a diameter of 3 inches but does not extend more than an inch or two above ground. The portion exposed to light develops normal green color. Plants are not killed, but stems are dwarfed and blossom production is curtailed.

Control. Sterilize soil or use fresh.

Rickettsialike bacteria. **Bacterial Wilt** on Toronto creeping bentgrass; bacteria found in xylem of roots, crown, and leaves. Initially, leaf blades wilt from tip down and within several days entire leaf wilts, becomes dark green, shriveled, and twisted; also leaf scorch of mulberry.

Enterobacteriaceae

Erwinia

Motile rods (usually) with peritrichous flagella; Gram-negative; producing acid with or without visible gas from a variety of sugars; invading tissues of living plants producing dry necroses, galls, wilts, and soft rots. The genus is named for Erwin F. Smith, pioneer in plant diseases caused by bacteria.

Enterobacter cloacae. **Bulb Decay** on onion.

Erwinia amylovora. **Fire Blight**, general on many species in several tribes of the Rosaceae, particularly serious on apple, pear, and quince. Other hosts include almond, amelanchier, apricot, aronia, blackberry, cherry, chokecherry, cotoneaster, crabapple, exochorda, geum, hawthorn, holodiscus, India hawthorn, kerria, Japanese quince, loquat, medlar, mountain-ash, plum, photinia, pyracantha, raspberry, rose, spirea, and strawberry.

Apparently a native disease, first noticed near the Hudson River in 1780, fire blight spread south and west with increased cultivation of pears and apples. By 1880 it had practically wrecked pear orchards in Illinois, Iowa, and other states in the Northern Mississippi Valley. Then it devastated pears on the Texas Gulf. Reaching California by 1910 it played havoc up the coast to Washington.

Symptoms. Blossoms and leaves of infected twigs suddenly wilt, turn dark brown to black, shrivel and die, but remain attached to twigs (see Fig. 3.4). The bark is shrunken, dark brown to purplish, sometimes blistered with gum oozing out. Brown or black blighted branches with dead persistent leaves look as if scorched by fire. The bacteria survive the winter in living tissue at the edge of "holdover cankers" on limbs. These are dead, slightly sunken areas with a definite margin or slight crack where dead tissue has shrunk away from living. In moist weather bacteria appear on the surface of cankers in pearly viscid drops of ooze, which is carried by wind-blown rain or insects to blossoms. Infection spreads from the blighted bloom to the young fruit, then down the pedicel to adjacent leaves, which turn brown, remaining hang-

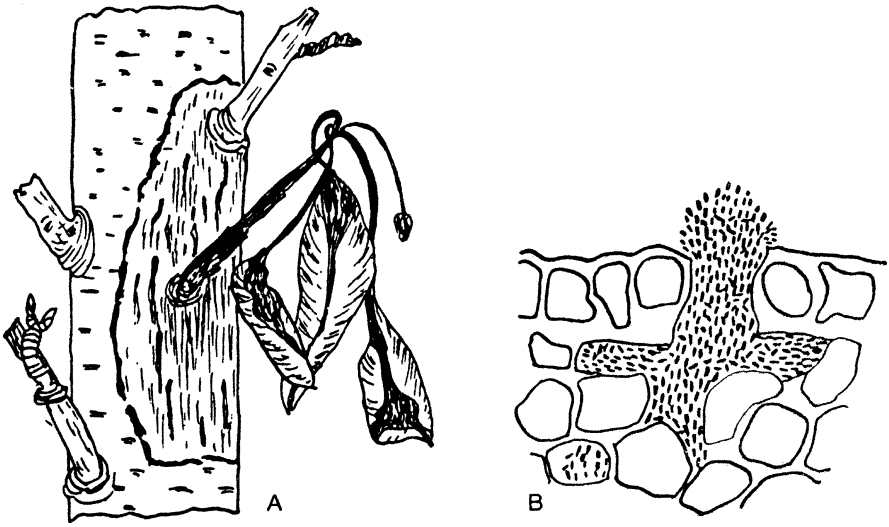

Figure 3.4 Fire Blight. **A** hold over canker developed on apple limb at base of blighted twig; **B** bacteria swarming through tissue

ing around the blighted blossom cluster. Leaf and fruit blight is also possible by direct invasion, a secondary infection via bacteria carried from primary blossom blight by ants, aphids, flies, wasps, fruit-tree bark beetles, and honeybees, sometimes tarnished plant bugs, and pear psyllids.

The tissue first appears water-soaked, then reddish, then brown to black as the bacteria swarm between the dying parenchyma cells. Division may take place every half hour; so they multiply rapidly and are usually well in advance of discolored external tissue. A collar rot may develop when cankers are formed near the base of a tree. Water sprouts are common sources of infection.

As spring changes to summer, the bacteria gradually become less active and remain dormant at the edge of a woody canker until the next spring at sap flow. Ordinarily they do not winter on branches smaller than 1/2 inch in diameter.

Control. Spraying during bloom is now a standard means of preventing blossom blight. Use bordeaux mixture or a fixed copper or streptomycin at 60 to 100 ppm. The latter is very effective at relatively high temperatures; at 65°F and below, copper is more satisfactory. Start spraying when about 10% of the blossoms are open and repeat at 5- to 7-day intervals until late bloom is over. A dormant spray for aphid control helps in preventing fire blight. One or more sprays may be needed for leafhoppers, starting at petal fall.

Inspect trees through the season and cut or break out infected twigs 12 inches below the portion visibly blighted. If lesions appear on large limbs they may be painted with one of the following mixtures:

I. 1 quart denatured alcohol, 1/4 pint distilled water, 3/4 ounce muriatic acid, 1 1/2 pounds zinc chloride.
II. 100 grams cobalt nitrate, 50 cc glycerine, 100 cc oil of wintergreen, 50 cc acetic acid, 80 cc denatured alcohol.
III. 5 parts cadmium sulfate stock solution (1 pound stirred into 2 pints warm water), 2 parts glycerine, 2 parts muriatic acid, 5 parts denatured alcohol.

Formulas I and II were developed for use on the West Coast, III for New York. The paint is brushed on the unbroken bark over the lesions and for several inches above and below the canker; it may injure if there are wounds or cuts.

In cutting out cankered limbs during the dormant season, take the branch off at least 4 inches back from edge of the canker, and disinfect the cut. The home gardener may want to use 10% Chlorox for tools and bordeaux paint for cut surfaces. Dry bordeaux powder is stirred into raw linseed oil until a workable paste is formed.

Almost all desirable pear varieties are susceptible to fire blight, particularly Bartlett, Flemish Beauty, Howell, Clapps Favorite. Varieties Old Home, Orient, and the common Kieffer are more or less resistant. Jonathon apples are very susceptible. Less apt to be severely blighted are Baldwin, Ben Davis, Delicious, Duchess, McIntosh, Northern Spy, Stayman, and Winter Banana.

At the University of California some work has been done on susceptibility of ornamentals to fire blight. *Pyracantha angustifolia* is quite susceptible, but *P. coccinea* and *P. crenulata* are rather resistant. *Cotoneaster salicifolia* is susceptible; *C. dammeri, C. pannosa*, and *C. horizontalis* are more resistant; and *C. adpressa* and *C. microphylla* show marked resistance.

Cultural methods influence the degree of fire blight, which is worse on fast-growing succulent tissue. Avoid heavy applications of nitrogen fertilizers; apply such nitrogen as is required in autumn or in spring in foliar sprays after danger of blossom blight is over.

Erwinia carnegieana. **Bacterial Necrosis** of giant cactus in the entire habitat of *Carnegia gigantea*. Long present in southern Arizona, this disease was not described until 1942, after it had encroached on cactus parks and private estates. Many giant cacti in the Saguaro National Monument have been killed, with heaviest mortality in trees 150 to 200 years old.

Symptoms start with a small, circular, light spot, usually with a water-soaked margin. The tissues underneath turn nearly black; the spot enlarges and has a purplish hue with the center cracking and bleeding a brown liquid. The rotten tissues dry, break up into granular or lumpy pieces, and fall to the ground. Rotting on one side means leaning to that side; when the trunk is girdled near the base, the giant is likely to fall in a wind-storm. If it does not break, it stands as a bare, woody skeleton, with all parenchyma tissue disintegrated. An insect, *Cactobrosis fernaldialis*, is largely responsible for the rapid spread of the disease. The larvae tunnel inside the stems most of the year, emerging from May to August to pupate for a month or so before the adult, a tan and brown nocturnal moth, lays eggs.

Control. A phosphate dust, applied monthly from April to September, has effectively controlled the insect vector. Incipient infections can be cut out and the cavity allowed to dry out and cork over. Before the insect vector was known, fallen trees were cut into short lengths, dragged to a burial pit, covered with a disinfectant, and then with soil.

Erwinia carotovora subsp. **carotovora** (formerly *Erwinia carotovora*). **Soft Rot** of calla, originally described from common calla, found on golden calla, and also on beet, cactus, cabbage, cauliflower, celery, cucumber, carrot, eggplant, geranium (*Pelargonium*), hyacinth, iris, onion, parsnip, pepper, potato, salsify, sansevieria, tobacco, tomato, and turnip.

On calla lily the soft rot starts in upper portion of the corm and progresses upward into leaf and flower stalks or down into roots, with the corm becoming soft, brown, and watery. Sometimes infection starts at edge of petiole, which turns slimy. Leaves with brown spots and margins die or rot off at the base before losing color. Flowers turn brown; stalks fall over; roots are soft and slimy inside the epidermis. Corms may rot so fast the plant falls over without other symptoms, or the diseased portion may dry down to sunken dark spots, in which the bacteria stay dormant to the next season.

On tomatoes, infection takes place through growth cracks, insect wounds, or sunscald areas. The tissue is at first water-soaked, then opaque, and in 3 to 10 days the whole fruit is soft, watery, colorless, with an offensive odor.

Control. Scrub calla corms, cut out rotted spots, and let cork over for a day or two. Plant in fresh or sterilized soil in sterilized containers and keep pots on clean gravel or wood racks, never on beds where diseased callas have grown previously. Grow at cool temperatures and avoid overwatering.

Erwinia carotovora subsp. **atroseptica** (formerly *Erwinia carotovora*). **Potato Blackleg**, **Basal Stem Rot**, **Tuber Rot**, general on potato. This

is a systemic disease perpetuated by naturally infected tubers. Lower leaves turn yellow; upper leaves curl upward; stems and leaves tend to grow up rather than spread out; stem is black-spotted, more or less softened at base and up to 3 or 4 inches from ground, and may be covered with bacterial slime; shoots may wilt and fall over. Tubers are infected through the stem end. The disease is most rapid in warm, moist weather, and may continue in storage. The bacteria are spread on the cutting knife, as with ring rot, and by seed-corn maggots, and may persist for a time in soil.

Control. Use certified seed potatoes and plant whole tubers; if cut seed must be used, allow to cork over to prevent infection from soil. Practice long rotation; disinfest cutting knife. Late varieties seem to be more resistant.

Erwinia carotovora subsp. **atroseptica** (formerly *Erwinia carotovora*). **Delphinium Blackleg**, **Foot Rot**, **Bacterial Crown Rot** of perennial Delphinium; **Stem and Bud Rot** of Rocket Larkspur. In delphinium there is a soft black discoloration at the base of the stem, with bacteria oozing out from cracks. In larkspur there is a black rot of buds as well as yellowing of leaves, blackening of stem, stunting of plants. The bacteria are apparently carried in seed; hot-water treatment is helpful. Drenching delphinium crowns with bordeaux mixture has been recommended in the past. Insect larval control is helpful with potato. Avoid excessive watering or irrigation.

Erwinia carotovora subsp. **carotovora** (formerly *Erwinia carotovora* var. *carotovora*). **Wilt** of sunflower, Kalanchoë; zucchini squash, and draceana. **Soft Rot**, general on many vegetables, in field, storage, and transit, and many ornamentals, especially iris. The bacteria were first isolated from rotten carrots, whence the name, but they are equally at home in asparagus, cabbage, turnips and other crucifers, celery, cucumber, eggplant, endive, garlic, horseradish, melon, parsnip, pepper, spinach, sunflower (stalk rot), sweetpotato, and tomato. Besides wide distribution on iris, soft rot has been reported, among ornamentals, on chrysanthemum, dahlia, Easter lily, geranium, orchid, sansevieria, poinsettia, and yellow calla.

The bacteria enter through wounds, causing a rapid, wet rot with a most offensive odor. The middle lamella is dissolved, and roots become soft and pulpy. Soft rot in iris often follows borer infestation. Tips of leaves are withered, the basal portions wet and practically shredded. The entire interior of a rhizome may disintegrate into a vile yellow mess while the epidermis remains firm. The rot is more serious in shaded locations, when iris is too crowded or planted too deeply.

Control. Borer control, starting when fans are 6 inches high, has greatly reduced the incidence of rot. If it appears, dig up the clumps, cut away all rotted portions, cut leaves back to short fans. Allow to dry in the sun for a day or two, then replant in well-drained soil, in full sun with upper portion of the rhizome slightly exposed. Many good iris growers do not agree with this "sitting duck" method, preferring to cover with an inch of soil; but the sun is an excellent bactericide, and shallow planting is one method of disease control. Clean off all old leaves in late fall after frost.

Prevent rot on stored vegetables by saving only sound, dry tubers, in straw or sand, in a well-ventilated room with temperature not too much above freezing. In the garden, rotate vegetables with fleshy roots with leafy varieties. Avoid bruising at harvest time.

Erwinia chrysanthemi. **Bacterial Blight** of Chrysanthemum, a florists' disease, first noted in 1950. First evidence of blight is a gray water-soaked area mid-point on the stem, followed by rot and falling over. The diseased tissue is brown or reddish brown; the rot progresses downward to the base of the stem or, under unfavorable conditions, may be checked with axillary buds below the diseased area producing normal shoots. Cuttings rot at the base. Sometimes affected plants do not show external symptoms, and cuttings taken from them spread the disease. Bacteria can be spread via cutting knife, or fingernails in pinching, and can live several months in soil. A form of this species causes a leaf blight of philodendron and may also infect banana, carnation, corn, and sorghum and pith/stem rot of tomato.

Control. Snap off cuttings; sterilize soil and tools.

Corn rot. Corn leaves show light or dark brown rotting at base; husks and leaf blades have dark brown spots; lower portion of stalk is rotten, soft, brown, with strong odor of decay; plants may break over and die, with little left but a mass of shredded remnants of fibrovascular bundles. Bacteria enter through hydathodes (water pores), stomata, and wounds.

Erwinia cypripedii. Reported from California, causing brown rot of Cypripedium orchids. Small, circular to oval, water-soaked, greasy light brown spots become sunken, dark brown to chestnut. Affected crowns shrivel; leaves drop.

Erwinia herbicola (see *Pantoea herbicola*). **Leaf Spot** of dracaena.

On Dracaena sanderana, gypsophila and related plants.

Erwinia nimipressuralis. **Wetwood** of elm, slime flux, due to bacteria pathogenic in elm trunk wood, especially Asiatic elms, but possibly occur-

ring in many other trees, including maple, oak, mulberry, poplar, and willow. A water-soaked dark discoloration of the heartwood is correlated with chronic bleeding at crotches and wounds and abnormally high sap pressure in trunk, with wilting a secondary symptom. The pressure in diseased trees increases from April to August or September, reaching 5 to 30 pounds per square inch (as much as 60 pounds in one record). The bacteria inhabit ray cells mostly and do not cause a general clogging of water-conducting tissues. This pressure, caused by fermentation of tissues by bacteria, causes fluxing, a forcing of sap out of trunks through cracks, branch crotches, and wounds. The flux flows down the trunk, wetting large areas of bark and drying to a grayish white incrustation. Bacteria and yeasts working in the flux cause an offensive odor that attracts insects.

Control. Bore drain holes through the wood below the fluxing wound, slightly slanted to facilitate drainage. Install 1/2-inch copper pipe to carry the dripping sap away from the trunk and buttress roots. Screw the pipe in only far enough to be firm; if it penetrates the water-soaked wood, it interferes with drainage.

Erwinia rhapontica. **Rhubarb Crown Rot**, similar to soft rot.

Erwinia stewartii (see *Pantoea stewartii*). **Bacterial Wilt** of corn, **Stewart's Disease** on sweet corn, sometimes field corn, in the middle regions of the United States, from New York to California.

Erwinia tracheiphila. **Bacterial Wilt** of cucurbits, **Cucumber Wilt** on cucumber, pumpkin, squash, and muskmelon but not watermelon. The disease is generally east of the Rocky Mountains and is also present in parts of the West; is most serious north of Tennessee. Total loss of vines is rare, but a 10 to 20% loss is common.

This is a vascular wound disease transmitted by striped and 12-spotted cucumber beetles. Dull green flabby patches on leaves are followed by sudden wilting and shriveling of foliage, and drying of stems. Bacteria ooze from cut stems in viscid masses. Partially resistant plants may be dwarfed, with excessive blooming and branching, wilting during the day but partially recovering at night. The bacteria winter solely in the digestive tract of the insects and are deposited on leaves in spring with excrement, entering through wounds or stomata.

Control is directed chiefly at the insects. Start vines under Hotkaps and spray or dust with rotenone or other insecticide when the mechanical protection is removed. Experimental spraying with antibiotics – streptomycin, terramycin, and neomycin has reduced wilt and increased yield.

Pantoea ananatis, **Leaf Blight** and **Bulb Decay** of onion.

Pantoea herbicola (formerly *Erwinia herbicola*). **Leaf Spot** of dracaena. On Dracaena sanderana, gypsophila and related plants. Galls are formed at crown and roots of grafted plants from 1/4 to 1 inch in diameter, but with a flat nodular growth rather than the usual globose crown gall.

Pantoea stewartii (formerly *Erwinia stewartii*). **Bacterial Wilt** of corn, **Stewart's Disease** on sweet corn, sometimes field corn, in the middle regions of the United States, from New York to California. This is a vascular disease with yellow slime formed in the water-conducting system, resulting in browning of nodes, and dwarfing of plants; or long pale green streaks on leaf blades, followed by wilting and death of whole plant. Tassels may be formed prematurely and die before the rest of the plant. The bacteria are chiefly disseminated by corn flea beetles, and winter either in the beetles or in seed. Primary infections come from flea beetles feeding in spring, from infected seed, and occasionally from soil; but secondary spread is mostly by insects.

Corn grown in rich soil is more susceptible to wilt, and so are early varieties, especially Golden Bantam. Winter temperatures influence the amount of wilt the following summer. If the winter index, which is the sum of mean temperatures for December, January, and February, is above 100, bacterial wilt will be present in destructive amounts on susceptible varieties. If the index is below 90, the disease will be very sparse in northeastern states; if the index is between 90 and 100, there will be a moderate amount of wilt. Disease surveys over a period of years testify to the reliability of such forecasts (based on the amount of cold the flea beetle vectors can survive); but with the increasing use of hybrid sweet corn resistant to wilt, the importance of winter temperatures is reduced.

Control. Use insecticides to control flea beetles; substitute commercial fertilizer for manure; destroy infected refuse; try treating seed with terracmycin or streptomycin. Use resistant varieties such as Golden Cross Bantam, Carmelcross, Ioana, Marcross, and Iochief.

Pseudomonadaceae

Pseudomonas

Motile with polar flagella; straight or curved rods; Gram-negative. Many species produce a greenish, water-soluble pigment. Many species are found in soil and water; many are plant pathogens causing leaf spots or blights.

Acidovorax avenae (formerly *Pseudomonas alboprecipitans*). **Bacterial Spot** of cereals, grasses, and corn. Light or dark brown spots or streaks on grass blades. Bacteria enter through stomata or water pores.
Acidovorax avenae (formerly *Pseudomonas avenae*). **Bacterial Leaf Spot** of sweet corn. **Bacterial Leaf Blight** of johnsongrass.
Acidovorax avenae subsp. **citrulli** (formerly *Pseudomonas pseudoalcaligenes*). **Angular Leaf Spot** of muskmelon and watermelon. Fruit blotch; on melon, squash, pumpkin, and watermelon.
Acidovorax cattleyae (formerly *Pseudomonas cattleyae*). **Brown Spot** of orchids, *Phalaenopsis* and *Cattleya*, common in greenhouses. Infection is through stomata of young plants, wounds of older plants. Dark green, circular water-soaked spots change to brown and finally black. On *Cattleya* the disease is limited to older leaves.
Burkholderia andropogonis (formerly *Pseudomonas andropogonis*). **Bacterial Stripe** of sorghum and corn. **Bacterial Leaf Spot** on bougainvillea. **Black Spot** on clovers and statice. Also causes blight of chickpea, and bacterial leaf spot on white clover. Red streaks and blotches appear on leaves and sheaths, with abundant exudate drying down to red crusts or scales, readily washed off in rains. Bacteria enter through stomata.
Bacterial Leaf Spot of velvet bean, clovers. Translucent angular brown leaf spots have lighter centers and chlorotic surrounding tissue; there is no exudate. Bacteria enter through stomata and fill intercellular spaces of parenchyma.
Burkholderia caryophylli (formerly *Pseudomonas caryophylli*). **Bacterial Wilt** of carnation, usually under glass. Plants wilt, turn dry, colorless with roots disintegrating. Grayish-green foliage is the first symptom, but leaves rapidly turn yellow and die. Yellow streaks of frayed tissue in vascular areas extend a foot or two up the stem. It takes a month for disease to show up after inoculation, but it can be transmitted on cuttings taken from plants before appearance of symptoms. The sticky character of diseased tissue distinguishes this wilt from Fusarium wilt. Varieties Cardinal Sim, Laddie, Mamie, Portrait, and others may have severe cankers at base of stems, orange-yellow when young, very sticky. Bacteria are spread by hands, tools, splashing water. Also causes crown and leaf rot of statice.
Control. Remove and burn diseased plants and all within 1 1/2 -foot radius. After handling wash with hot water and soap, sterilize tools (10% Clorox for 5 minutes). Obtain rooted cuttings from propagators of cultured, disease-free material; keep in shipping bags until ready for benching and then place in

raised, steam-pasteurized benches. Never place cuttings in water or a liquid fungicide (use dust if a fungicide is required for other diseases); never place temporarily on an unsterilized table; never cut or trim with hands or knives; never plant in outdoor "nurse beds"; never use overhead watering.

Burkholderia cepacia (formerly *Pseudomonas cepacia*). **Sour Skin Rot** of onion. Slimy yellow rot of outer fleshy scales, with a vinegar odor. Let crop mature well before harvesting, tops dry before topping; cure bulbs thoroughly before storage.

Burkholderia gladioli (formerly *Pseudomonas gladioli*). **Leaf Spot** and **Blight** on bird's nest fern.

Onion Bulb Rot, a storage disease, inner scales of bulb water-soaked and soft, sometimes entire bulb rotting.

Orchid Brown Rot and **Leaf Spot**.

Gladiolus Scab, **Stem Rot**, **Neck Rot**, widespread on gladiolus, also on iris, bell peppers and tigridia. Lesions on corms are pale yellow, water-soaked circular spots deepening to brown or nearly black, eventually sunken with raised, horny, or brittle margins that are scablike and exude a gummy substance. Bacteria overwinter on corms. First symptoms after planting are tiny reddish raised specks on leaves, mostly near the base, enlarging to dark sunken spots, which grow together into large areas with a firm or soft rot. Sometimes plants fall over, but the disease is not ordinarily very damaging in the garden. The chief loss is to the grower in disfigured, unsalable corms. Brown streaks in husks sometimes disintegrate, leaving holes.

Gladiolus scab is increased by bulb mites, may be related to grub and wireworm injury.

Pseudomonas aceris (see *Pseudomonas syringae* pv. *aceris*). **Maple Leaf Spot** found in California on big leaf maple.

Pseudomonas adzukicola. **Stem Rot** of adzuki bean.

Pseudomonas alboprecipitans (see *Acidovorax avenae*). **Bacterial Spot** of cereals, grasses, and corn.

Pseudomonas andropogonis (see *Burkholderia andropogonis*). **Bacterial Stripe** of sorghum and corn.

Bacterial Leaf Spot of velvet bean, clovers. Translucent angular brown leaf spots have lighter centers and chlorotic surrounding tissue; there is no exudate. Bacteria enter through stomata and fill intercellular spaces of parenchyma.

Pseudomonas angulata (see *Pseudomonas syringae* pv. *angulata*). **Blackfire** of tobacco.

Pseudomonas asplenii. **Bacterial Leaf Blight** of bird's-next fern, first reported from greenhouses in California. Small translucent spots enlarge to cover whole frond; bacteria may invade crown and kill whole plant. Control depends on strict sanitation – sterilizing flats, pots, media, and foreceps used in transplanting. Avoid excessive watering and too high humidity.
Pseudomonas avenae (see *Acidovorax avenae*). **Bacterial Leaf Spot** of sweet corn. **Bacterial Leaf Blight** of johnsongrass.
Pseudomonas berberidis. **Bacterial Leaf Spot** of barberry. Small, irregular, dark green water-soaked areas on leaves turn purple-brown with age; occasional spotting occurs on leaf stalks and young shoots. If twigs are infected, buds do not develop in the next season; if they are girdled, the entire twig is blighted. Cut out infected twigs and spray with bordeaux mixture or an antibiotic.
Pseudomonas caryophylli (see *Burkholderia caryophylli*). **Bacterial Wilt** of carnation, usually under glass.
Pseudomonas cattleyae (see *Acidovorax cattleyae*). **Brown Spot** of orchids, *Phalaenopsis* and *Cattleya*, common in greenhouses.
Pseudomonas cepacia (see *Burkholderia cepacia*). **Sour Skin Rot** of onion. Slimy yellow rot of outer fleshy scales, with a vinegar odor.
Pseudomonas cichorii. **Bacterial Leaf Spot** on basil. **Bacterial Blight** on Lobelia.
Pseudomonas cichorii. **Bacterial Rot** of chicory, Belgium endive, French endive, iris, **Soft Rot** of potato, and **Bacterial Leaf Spot** of hibiscus, geranium, magnolia and rhododendron. May also cause a **Leaf Spot** and **Stem Necrosis** on chrysanthemum (see Fig. 3.5) and **Bacterial Leaf Blight** on dwarf *Schefflera*. A yellowish olive center rot, affecting young inner leaves.
Pseudomonas corrugata. **Stem Rot** of tomato, also **Pith Necrosis**.
Pseudomonas fluorescens (*marginalis*). **Marginal Blight** of lettuce, **Kansas Lettuce Disease**, also on witloof chicory, **Soft Rot** of potato tubers. Leaf margins are dark brown to almost black, first soft, then like parchment. Yellowish red spots, turning dark, are scattered over leaves. Infected tissue disintegrates into an odorous mass. Bacteria live in the soil, which should not be splashed on plants by careless watering.
Pseudomonas gladioli (see *Burkholderia gladioli*). **Leaf Spot** and **Blight** on bird's nest fern.
Pseudomonas melophthora. **Apple Rot**, probably widespread. This is a decay of ripe apples following after apple maggots and eventually rotting whole fruit.

Figure 3.5 Bacterial Black Spot on Chrysanthemum

Pseudomonas pseudoalcaligenes (see *Acetovorax avenae* subsp. *citrulli*). **Angular Leaf Spot** of muskmelon and watermelon. **Fruit Blotch** on melon, squash, pumpkin, and watermelon.
Pseudomonas ribicola. On golden currant in Wyoming.
Pseudomonas sesami. **Bacterial Leaf Spot** of sesame. Brown spots on leaves and stems. Can be controlled by treating seed with streptomycin.
Pseudomonas solanacearum (see *Rolstonia solanacearum*). **Southern Bacterial Wilt**, also called **Brown Rot**, **Bacterial Ring Disease**, **Slime Disease**, **Granville Wilt** (of tobacco), present in many states but particularly prevalent in the South, from Maryland around the coast to Texas.
Pseudomonas syringae. **Canker** on kiwifruit; also **Blight** on impatiens and mock orange. Also **Leaf Spot** on English and American elm, mountain-laurel, arugula and coriander. **Stem Dieback** of Centaurea and fennel.
Pseudomonas syringae pv. **aceris** (formerly *Pseudomonas aceris*). **Maple Leaf Spot** found in California on big leaf maple. Small, water-soaked spots, surrounded by yellow zones, turn brown or black; cankers develop on petioles and bracts in serious cases; leaves may drop; disease present in cool, damp weather of early spring.
Pseudomonas syringae pv. **angulata** (formerly *Pseudomonas angulata*). **Blackfire** of tobacco.

Pseudomonas syringae pv. **apii**. **Bacterial Blight** of celery. Small, irregularly circular rusty leaf spots, with a yellow halo, are occasionally numerous enough to cause death of foliage, but commonly are only disfiguring. Spray plants in seedbed with bordeaux mixture, or dust with copper lime dust; clean up old refuse.

Pseudomonas syringae pv. **apii**. **Bacterial Leaf Spot** of celery.

Pseudomonas syringae pv. **aptata**. **Bacterial Spot** on beets, Swiss chard, and nasturtium. Spots on nasturtium leaves are water-soaked, brownish, 1/8 to 1/4 inch across. On beets they are dark brown or black, irregular, and in addition there are narrow streaks on petioles, midribs, and larger veins. Petiole tissue may be softened as with soft rot. Infection is only through wounds.

Pseudomonas syringae pv. **coronafaciens**. **Halo Blight** on grasses, such as *Poa* spp. and *Calamagrostis* spp.

Pseudomonas syringae pv. **delphinii**. **Delphinium Black Spot** on delphinium and aconite (monkshood). Irregular tarry black spots on leaves, flower buds, petioles, and stems may coalesce in late stages to form large black areas. The bacteria enter through stomata or water pores. Occasionally this bacterial leaf spot results in some distortion, but most abnormal growth and blackening of buds is due to the cyclamen mite, a much more important problem than black spot.

Control. Remove diseased leaves as noticed; cut and burn all old stalks at end of season; avoid overhead watering. In a wet season spraying with bordeaux mixture may have some value.

Pseudomonas syringae pv. **glycinea**. **Bacterial Blight** of soybean. Perhaps the most common and conspicuous disease of soybean, appearing in fields when plants are half-grown and remaining active until maturity, with defoliation during periods of high humidity or heavy dews. Small, angular, translucent leaf spots, yellow to light brown, turn dark reddish brown to nearly black with age. There is often a white exudate drying to a glistening film on under leaf surfaces. Black lesions appear on stems and petioles, and on pods water-soaked spots enlarge to cover a wide area, darken, and produce an exudate drying to brownish scales; seeds are often infected. Seedlings from infected seed have brown spots on cotyledons and often die. Flambeau and Hawkeye varieties are somewhat less susceptible. Use seed taken from disease-free pods.

Pseudomonas syringae pv. **helianthi**. **Bacterial Leaf Spot** of sunflower. Leaves show brown, necrotic spots, first water-soaked, then dark and oily.

Pseudomonas syringae pv. **hibisci**. **Bacterial Leaf Spot** on *Hibiscus*.

Pseudomonas syringae pv. **lachrymans**. **Angular Leaf Spot** of cucurbits, general on cucumber, muskmelon, summer squash, occasional on other cucurbits. Leaves or stems have irregular, angular, water-soaked spots with bacteria oozing out in tearlike droplets that dry down to a white residue. Eventually the spots turn gray, die, and shrink, leaving holes in foliage. Fruit spots are small, nearly round, with the tissue turning white, sometimes cracking. The bacteria overwinter in diseased plant tissue and in the seed coat. They are spread from soil to stems and later to fruit in rainy weather, also transferred from plant to plant on hands and clothing. Infection is most severe in plants gone over by pickers early in the morning before dew has dried off. *Control*. Plow under or remove vines immediately after harvest.

Pseudomonas syringae pv. **mori**. **Bacterial Blight** of mulberry, general on black and white mulberry. Numerous water-soaked leaf spots join to form brown or black areas with surrounding yellow tissue. Young leaves may be distorted, with dark sunken spots on midribs and veins. Dark stripes with translucent borders on young shoots exude white or yellow ooze from lenticels. Dead twigs and brown leaves resemble fire blight; trees are stunted but seldom killed. Remove and burn blighted branches; do not plant young mulberry trees near infected specimens.

Pseudomonas syringae pv. **mors-prunorum**. **Bacterial Canker** of stone fruits, **Citrus Blast**, **Lilac Blight** on many unreleated plants, including apple, plum, peach, cherry, pear, almond, avocado, citrus fruits, lilacs, flowering stock, rose, beans, cowpeas, oleander, and leaf spot on peas.

On stone fruits all plant parts are subject to attack, but most destructive are elongated water-soaked lesions or gummy cankers on trunks and branches, usually sour-smelling. Dormant buds of cherry and apricot are likely to be blighted, pear blossoms blasted. Small purple spots appear on leaves of plum and apricot, black lesions on fruit of cherry and apricot. All varieties of apricot are very susceptible to the disease. Plums on Myrobalan rootstock are more resistant, and varieties California, Duarte, and President are tolerant.

On citrus, and particularly lemons, dark sunken spots, called black pit, are formed on fruit rind, but there is no decay. The blast form of the disease is most often on oranges and grapefruit – water-soaked areas in leaves, which may drop or hang on, twigs blackened and shriveled. The disease is most serious in seasons with cold, driving rainstorms.

On lilac, brown water-soaked spots on leaves and internodes on young shoots blacken and rapidly enlarge. Young leaves are killed; older leaves have large

portions of the blade affected. Infection starts in early spring in rainy weather. The bacteria are primarily in the parenchyma, spreading through intercellular spaces, blackening and killing cells, forming cavities. The vascular system may also be affected, followed by wilting of upper leaves.

Control. Prune out infected twigs and branches. In California spray fruits in fall with bordeaux mixture, at the time first leaves are dropping. Grow bushy, compact citrus trees less liable to wind injury; use windbreaks for orchards.

Pseudomonas syringae pv. **papulans**. **Blister Spot** of apple. Small, dark brown blisters on fruit and rough bark cankers on limbs start at lenticels. Bark may have rough scaly patches from a few inches to a yard long, bordered with a pimpled edge, and with outer bark sloughing off in spring.

Pseudomonas syringae pv. **phaseolicola**. **Bean Halo Blight**, halo spot on common, lima, and scarlet runner beans. The symptoms are those of other bean blights except that there are wide green or yellowish green halos around water-soaked leaf spots, such spots later turning brown and dry. Leaves wilt and turn brown; young pods wither and produce no seed; sometimes plants are dwarfed with top leaves crinkled and mottled. In hot weather, spots are often angular, reddish brown, and without halo. Stem streaks are reddish, with gray ooze; pod spots are red to brown with silver crusts; seeds are small, wrinkled, with cream-colored spots. All snap beans are susceptible; many dry beans – Pinto, Great Northern, Red Mexican, Michelite – are rather resistant.

Control. Use seed from blight-free areas. Blight is rare in California, occasional in Idaho. Plan a 3-year rotation. Do not pick beans when foliage is wet.

Pseudomonas syringae pv. **pisi**. **Bacterial Blight** of pea, general on field and garden peas, especially in East and South, and causing a leaf spot of sweet peas. Dark green water-soaked dots on leaves enlarge and dry to russet brown; stems have dark green to brown streaks. Flowers are killed or young pods shriveled, with seed covered with bacterial slime. Bacteria enter through stomata or wounds, and if they reach the vascular system, either leaflets or whole plants wilt. Vines infected when young usually die. Alaska and Telephone varieties are particularly susceptible.

Control. Avoid wounding vines during cultivation. Sow peas in early spring in well-drained soil. Use disease-free seed and plan a 4-year rotation.

Pseudomonas syringae pv. **porri**. **Bacterial Blight** of shallot.

Pseudomonas syringae pv. **primulae**. **Bacterial Leaf Spot** of primrose in ornamental and commercial plantings in California. Infection is confined to

older leaves – irregularly circular brown lesions surrounded by conspicuous yellow halos. Spots may coalesce to kill all or part of leaf. Spraying with bordeaux mixture has prevented infection.

Pseudomonas syringae pv. **savastanoi**. **Olive Knot**, **Bacterial Knot** of olive. Irregular, spongy, more or less hard, knotty galls on roots, trunk, branches, leaf, or fruit pedicels start as small swellings and increase to several inches with irregular fissures. Terminal shoots are dwarfed or killed; whole trees may die. Bacteria enter through wounds, often leaf scars or frost cracks. Variety Manzanilla is most susceptible of the olives commonly grown in California. Another form of this species causes similar galls on ash.

Control. Cut out galls carefully, disinfesting tools; paint larger cuts with bordeaux paste and spray trees with bordeaux mixture in early November, repeating in December and March if infection has been abundant. Do not plant infected nursery trees or bring equipment from an infected orchard into a healthy one.

Pseudomonas syringae pv. **syringae**. **Brown Spot, Foliar** on wild rice (*Zizania*); leaf spot and stem collapse on urd bean; leaf spot and stem canker on Ginkgo.

Oleander Bacterial Gall. Galls or tumors are formed on branches, herbaceous shoots, leaves, and flowers but not on underground parts. Small swellings develop on leaf veins, surrounded by yellow tissue, with bacterial ooze coming from veins in large quantity. Young shoots have longitudinal swellings with small secondary tubercles; young leaves and seedpods may be distorted and curled. On older branches tumors are soft or spongy and roughened with projecting tubercles; they slowly turn dark. Prune out infected portions, sterilizing shears between cuts; propagate only from healthy plants.

Pseudomonas syringae pv. **tabaci** (see *Pseudomonas tabaci*). **Blackfire** of tobacco.

Pseudomonas syringae pv. **tabaci**. **Tobacco Wildfire** on tobacco, tomato, eggplant, soybean, cowpea, pokeberry, and ground-cherry, in all tobacco districts sporadically. Leaf spots have tan to brown dead centers with chlorotic halos. The disease appears first on lower leaves and spreads rapidly in wet weather. The bacteria persist a few months in crop refuse and on seed and enter through stomatal cavities. In buried soybean leaves the bacteria have lived less than 4 months; so fall plowing may be beneficial. Seed stored for 18 months produces plants free from wildfire.

Pseudomonas syringae pv. **tagetis**. **Bacterial Leaf Spot**. Circular necrotic lesions on leaves and petioles. The lesions have dark purple margins. This disease occurs on marigold, sunflower, Jerusalem artichoke, and common ragweed. Apical chlorosis is also caused by this pathogen on sunflower and sunflower seed may be a source of inoculum.

Pseudomonas syringae pv. **tagetis**. **Bacterial Leaf Spot** on compass plant and sunflower.

Pseudomonas syringae pv. **tomato**. **Bacterial Leaf Spot** of crucifers, **Pepper Spot** of cabbage, cauliflower, chinese cabbage, and turnip, mostly in northeastern and Middle Atlantic states. Numerous brown or purple spots range from pinpoint to 1/8 inch in diameter. If spots are very numerous, leaves yellow and drop off. Cauliflower is more commonly affected than cabbage. Bacteria, disseminated on seed or in diseased plant parts, enter through stomata, and visible symptoms appear in 3 to 6 days. Disease is most severe in seedbeds.

Control. Change location of hotbed starting seedlings; use 2-year rotation in field; have seed hot-water treated.

Pseudomonas syringae pv. **tomato**. **Bacterial Speck** of tomato. Numerous, dark brown raised spots on fruit are very small, less than 1/16 inch; they do not extend into flesh and are more disfiguring than harmful.

Pseudomonas syringae pv. **zizaniae**. **Leaf Spot** and **Stem Spot** of wild rice.

Pseudomonas tabaci (see *Pseudomonas syringae* pv. *tabaci*). **Blackfire** of tobacco.

Pseudomonas viburni. **Bacterial Leaf Spot** of viburnum, widespread. Circular water-soaked spots appear on leaves, and irregular sunken brown cankers on young stems, and the bacteria overwinter in leaves, stems or buds. Remove and burn infected leaves. Spray with bordeaux mixture or an antibiotic such as Agrimycin two or three times at weekly intervals.

Pseudomonas viridiflava. **Bacterial Leaf Spot** on basil. **Bacterial Canker** on poinsettia.

Pseudomonas viridilivida. **Louisiana Lettuce Disease** on lettuce, bell pepper, and tomatoes. Numerous water-soaked leaf spots fuse to infect large areas, first with a soft rot, then a dry shriveling. Sometimes outer leaves are rotted and the heart sound. This bacterium also causes greasy canker of poinsettia.

Pseudomonas washingtoniae. This bacterium causes spots on leaves of Washington palm.

Pseudomonas woodsii. **Bacterial Spot** and **Blight** of carnation. Leaf lesions are small, elongated, brown with water-soaked borders, withering to brown sunken areas, with masses of bacteria oozing out of stomata. They are spread in greenhouses by syringing, and outdoors by rain. Follow cultural practices suggested under *P. caryophylli* for carnation wilt.

Pseudomonas sp. **Blueberry Canker** reported from Oregon. Reddish brown to black cankers appear on canes of the previous season; all buds in the cankered areas are killed; stems are sometimes girdled. Varieties Weymouth, June, and Rancocas are resistant, but Jersey, Atlantic, Scammel, Coville, and Evelyn are highly susceptible.

Rhizomonas suberifaciens. **Corky Rot** on lettuce.

Rolstonia solanacearum (formerly *Pseudomonas solanacearum*). **Southern Bacterial Wilt**, also called **Brown Rot**, **Bacterial Ring Disease**, **Slime Disease**, **Granville Wilt** (of tobacco), present in many states but particularly prevalent in the South, from Maryland around the coast to Texas. Southern wilt is common on potatoes in Florida but also appears on many other vegetables – bean, lima bean, castor bean, soybean, velvet bean, beet, carrot, cowpea, peanut, sweetpotato, tomato, eggplant, pepper, and rhubarb. Ornamentals sometimes infected include ageratum, anthurium, dwarf banana, garden balsam, geranium, canna, cosmos, croton, chrysanthemum, dahlia, hollyhock, lead-tree, marigold, nasturtium, Spanish needle, sunflower, and zinnia. The symptoms are those of a vascular disease, with dwarfing or sudden wilting, a brown stain in vascular bundles, and dark patches or streaks in stems. Often the first symptom is a slight wilting of leaves at end of branches in the heat of the day, followed by recovery at night, but each day the wilting is more pronounced and recovery less until the plant dies. Young plants are more susceptible than older ones. In potatoes and tomatoes there may be a brown mushy decay of stems, with bacterial ooze present. Potato tubers often have a browning of vascular ring, followed by general decay.

Bacteria live in fallow soil 6 years or more and may persist indefinitely in the presence of susceptible plants. They are spread by irrigation water, in crop debris, or soil fragments on tools and tractors, or by farm animals. Optimum temperatures are high, ranging from 77° to 97°F, with inhibition of disease below 55°F.

Control. Use northern-grown seed potatoes and Sebago and Katahdin varieties, more resistant than Triumph and Cobbler. Use a long rotation for toma-

toes. Soil can be acidified with sulfur to kill bacteria, followed by liming in the fall before planting.

Xanthomonas

Small rods, motile with a single polar flagellum; form abundant slimy yellow growth. Most species are plant pathogens causing necroses.

Ralstonia solanacearum, Race 3, Biovar 2. **Bacterial wilting** of geranium; also yellowing and stunting.

Xanthomonas albilineans. **Leaf Scald** of sugarcane (FL, TX).

Xanthomonas axonopodis. **Leaf Streak** (water soaking) of African lily and **Leaf Blight** of onion.

Xanthomonas begoniae (see *Xanthomonas campestris* pv. *begoniae*). **Begonia Bacteriosis**, leaf spot of fibrous and tuberous begonias.

Xanthomonas campestris. **Black Rot** of cruciers, **Bacterial Blight**, **Wilt**, **Stump Rot** of alder, arabidopsis, asparagus tree fern, avocado, cabbage, cauliflower, broccoli, brussels sprouts, kale, lavender, mustard, radish, rutabaga, sunflower, stock, turnip, and leaf blight of onion. Black rot was first observed in Kentucky and Wisconsin about 1890 and is generally distributed in the country, with losses often 40 to 50% of the total crop. It is one of the most serious crucifer diseases, present each season but epidemic in warm, wet seasons.

The bacteria invade leaves through water pores or wounds and progress to the vascular system. Veins are blackened, with leaf tissue browning in a V-shape. With early infection plants either die or are dwarfed, with a one-sided growth. Late infection results in defoliation, long bare stalks with a tuft of leaves on top. When stems are cut across, they show a black ring, result of the vascular invasion, and sometimes yellow bacterial ooze. Black rot is a hard odorless rot, but it may be followed by soft, odorous decays. Primary infection comes from bacteria carried on seed, or in refuse in soil, but drainage water, rain, farm implements, and animals aid in secondary infection.

Control. Use seed grown in disease-free areas in the West or treat with hot water, 122°F, 25 minutes for cabbage, 18 minutes for broccoli, cauliflower, and collards. Plan a 3-year rotation with plants other than crucifers, and clean up all crop refuse.

Xanthomonas campestris. **Horse-Radish Leaf Spot**. Leaves are spotted but there is no vascular infection. Also causes leaf spot of *Pilea* sp., *Pellionia*

sp. and leaf spot and blight of bird of paradise, white butterfly. Also, bacterial leaf and stem lesions.

Xanthomonas campestris. **Bacterial Leaf Spot** on cabbage and radish.

Xanthomonas campestris pv. **asclepiadis**. **Bacterial Blight** on butterfly weed.

Xanthomonas campestris pv. **barbareae**. **Black Rot** of winter-cress (*Barbarea vulgaris*), similar to black rot of cabbage; small greenish spots turn black.

Xanthomonas campestris pv. **begoniae** (formerly *Xanthomonas begoniae*). **Begonia Bacteriosis**, leaf spot of fibrous and tuberous begonias. Blister-like, roundish dead spots are scattered over surface of leaves. Spots are brown with yellow translucent margins. Leaves fall prematurely, and in severe cases the main stem is invaded, with gradual softening of all tissues and death of plants. Bacteria remain viable at least 3 months in yellow ooze on surface of dried leaves. Leaves are infected through upper surfaces during watering, with rapid spread of disease when plants are crowded together under conditions of high humidity.

Control. Keep top of leaves dry, avoiding syringing or overhead watering; keep pots widely spaced; spray with bordeaux mixture and dip cuttings in it.

Xanthomonas campestris pv. **carotae** (formerly *Xanthomonas carotae*). **Bacterial Blight** of carrot. The chief damage is to flower heads grown for seed, which may be entirely killed. Symptoms include irregular dead spots on leaves, dark brown lines on petioles and stems, blighting of floral parts, which may be one-sided. Use clean seed, or treat with hot water; rotate crops.

Xanthomonas campestris pv. **citri**. **Citrus Canker** on all citrus fruits, but not apparently eradicated from the United States. It came from the Orient and appeared in Texas in 1910, becoming of major importance in Florida and the Gulf States by 1914, ranking with chestnut blight and white pine blister rust as a national calamity. But here is one of the few cases on record where man has won the fight, where a disease has been nearly eradicated by spending enough money and having enough cooperation early in the game. Several million dollars, together with concerted intelligent effort by growers, quarantine measures, destruction of every infected tree, sanitary precautions so rigid they included walking the mules through disinfestant, sterilization of clothes worn by workers – ill saved us from untold later losses.

Symptoms of citrus canker are rough, brown corky eruptions on both sides of leaves and fruit. On foliage the lesions are surrounded by oily or yellow halos. Old lesions become brown and corky.

Xanthomonas campestris pv. **corylina** (formerly *Xanthomonas corylina*). **Filbert Blight**, **Bacteriosis**, the most serious disease of filberts in the Pacific Northwest, known since 1913 from the Cascade Mountains west in Oregon and Washington. The disease is similar to walnut blight (see *X. juglandis*) with infection on buds, leaves, and stems of current growth; on branches; and on trunks 1 to 4 years old. The bacteria are weakly pathogenic to the nuts. Copper-lime dusts are effective, with four to six weekly applications, starting at the early prebloom stage.

Xanthomonas campestris pv. **cucurbitae** (formerly *Xanthomonas cucurbitae*). **Bacterial Spot** on winter squash and pumpkin. Leaf spots are first small and round, then angular between veins, with bright yellow halos; sometimes translucent and thin but not dropping out; often coalescing to involve whole leaf. Bacterial exudate is present.

Xanthomonas campestris pv. **cyamopsidis**. **Rot** of *Lithops* spp.

Xanthomonas campestris pv. **dieffenbachiae**. **Blight** of *Anthurium*; also **Leaf Spot** of cocoyam.

Xanthomonas campestris pv. **dieffenbachiae** (formerly *Xanthomonas dieffenbachiae*). **Dieffenbachia Leaf Spot**. Spots are formed on all parts of leaf blade except midrib, but not on petioles and stems. They range from minute, translucent specks to lesions 3/8 inch in diameter, circular to elongated, yellow to orange-yellow with a dull green center. Spots may grow together to cover large areas, which turn yellow, wilt, and dry. Dead leaves are dull tan to light brown, thin and tough but not brittle. The exudate on lower surface of spots dries to a waxy, silver-white layer.

Control. Separate infected from healthy plants; keep temperature low; avoid syringing; try protective spraying with streptomycin.

Xanthomonas campestris pv. **fragariae**. **Angular Leaf Spot** on strawberry; also **Blossom Blight** on strawberry.

Xanthomonas campestris pv. **glycines** (formerly *Xanthomonas glycines* (*phaseoli* var. *sojense*). **Bacterial Pustule** of soybean, similar to regular bean blight but chiefly a foliage disease, present in most soybean areas, more severe in the South. Small, yellow-green spots with reddish brown centers appear on upper surface of leaves with a small raised pustule at the center of the spot on the under leaf surface. Spots run together to large irregular brown areas, portions of which drop out, giving a ragged appearance.

Bacteria overwinter in diseased leaves and on seed. Variety CNS is highly resistant; Ogden has some resistance.

Xanthomonas campestris pv. **gummisudans** (formerly *Xanthomonas gummisudans*). **Bacterial Blight** of Gladiolus. Narrow, horizontal, water-soaked, dark green spots turn into brown squares or rectangles between veins, covering entire leaf, particularly a young leaf, or middle section of the blade. Bacteria ooze out in slender, twisted, white columns or in a gummy film, in which soil and insects get stuck. Disease is spread by planting infected corms or by bacteria splashed in rain from infected to healthy leaves. The small dark brown corm lesions are almost unnoticeable. Soak corms unhusked for 2 hours before planting.

Xanthomonas campestris pv. **hederae** (formerly *Xanthomonas hederae*). **Bacterial Leaf Spot** of English ivy. Small water-soaked area on leaves develop dark brown to black centers as they increase in size, sometimes cracking, with reddish purple margins. Spots are sometimes formed on petioles and stems, with plants dwarfed and foliage yellow-green. Spray with bordeaux mixture or an antibiotic. Keep plants well spaced; avoid overhead watering and high humidity.

Xanthomonas campestris pv. **hyacinthi** (formerly *Xanthomonas hyacinthi*). **Hyacinth Yellows**, yellow rot of Dutch hyacinth, occasionally entering the country in imported bulbs. The disease was first noted in Holland in 1881 and named for the yellow slime or bacterial ooze seen when a bulb is cut. The bulbs rot either before or after planting, producing no plants above ground or badly infected specimens, which do not flower and have yellow to brown stripes on leaves or flower stalks. Bacteria are transmitted by wind, rain, tools, and clothes, with rapid infection in wet or humid weather, particularly among luxuriantly growing plants. The disease is usually minor in our Pacific Northwest but worse in warm, wet weather on rapidly growing plants. Innocence is more susceptible than King of the Blues.

Control. Cover infected plants with a jar or can until the end of the season; then dig after the others. Never work or walk in fields when plants are wet; avoid bruising; discard rotten bulbs; rotate plantings; avoid fertilizer high in nitrogen.

Xanthomonas campestris pv. **incanae** (formerly *Xanthomonas incanae*). **Bacterial Blight** of garden stocks causing, since 1933, serious losses on flower-seed ranches in California; also present in home gardens. This is a vascular disease of main stem and lateral branches, often extending into leaf petioles and seed peduncles. Seedlings suddenly wilt when 2 to 4 inches

high, with stem tissues yellowish, soft and mushy, and sometimes a yellow exudate along stem. On older plants, dark water-soaked areas appear around leaf scars near ground, stem is girdled, and lower leaves turn yellow and drop; or entire plants wilt or are broken by wind at ground level. Bacteria persist in soil and on or in seed;they are also spread in irrigation water.
Control. Use a 2 to 3-year rotation. Treat seed with hot water, 127.5° to 131°F for 10 minutes, followed by rapid cooling.
Xanthomonas campestris pv. **juglandis** (formerly *Xanthomonas juglandis*). Walnut Blight on English or Persian walnut, black walnut, butternut, Siebold walnut. Black, dead spots appear on young nuts, green shoots, and leaves. Many nuts fall prematurely, but others reach full size with husk, shell, and kernel more or less blackened and destroyed. Bacteria winter in old nuts or in buds, and may be carried by the walnut erinose mite.
Control. Spray with a fixed copper, as copper oxalate, or with streptomycin. Apply when 10% of the blossoms are open, repeat when 20% are open, and again after bloom.
Xanthomonas campestris pv. **malvacearum**. Leaf Spot on *Hibiscus*.
Xanthomonas campestris pv. **oryzae** (formerly *Xanthomonas oryzae*). Carnation Pimple reported from Colorado as caused by a new form of the rice blight organism. Very small, 1 mm, pimples are formed near base and tips of leaves, which may shrivel.
Xanthomonas campestris pv. **papavericola** (formerly *Xanthomonas papavericola*). Bacterial Blight of poppy on corn poppy and on Oriental, opium, and California poppies. Minute, water-soaked areas darken to intense black spots bounded by a colorless ring. Spots are scattered, circular, small, often zonate, with tissue between yellow and then brown. There is a noticeable, slimy exudate. Infection is through stomata and often into veins. Stem lesions are long, very black, sometimes girdling and causing young plants to fall over. Flower sepals are blackened, petals stop developing; pods show conspicuous black spots.
Control. Remove and destroy infected plants; do not replant poppies in the same location. Try Agrimycin as a preventive spray.
Xanthomonas campestris pv. **pelargonii** (formerly *Xanthomonas pelargonii*). Bacterial Leaf Spot of geranium (*Pelargonium*). Irregular to circular brown leaf spots start as water-soaked dots on undersurface, becoming sunken as they enlarge and with tissue collapsing. If spots are numerous, the entire leaf turns yellow, brown, and shriveled, then drops. The leaves sometimes wilt and droop but hang on the plant for a week or so. Exterior of

stem is gray and dull, the pith and cortex black, later disintegrating into a dry rot. The roots are blackened but not decayed. Cuttings fail to root, and rot from the base upward. Bacteria can live 3 months in moist soil; are spread by handling, splashing water, cutting knives, and whiteflies.

Control. Remove diseased plants. Take cuttings from plants known to be healthy; place in sterilized media and pots. Commercial growers should purchase culture-indexed cuttings. Be sure to sterilize cutting knives. Use 1-year rotation. Try Agrimycin as a preventive spray, or copper.

Xanthomonas campestris pv. **pelargonii** (formerly *Xanthomonas pelargonii*) **Geranium Leaf Spot** on *Pelargonium* spp. Leaf spots are small, brown, necrotic, sometimes with reddish tinge on upper surface and a slightly water-soaked condition on underside. Young leaves may die and drop. Petioles are occasionally spotted. Bacteria winter in old leaves or under mulch.

Xanthomonas campestris pv. **phaseoli** (formerly *Xanthomonas phaseoli*). **Bacterial Bean Blight**, general and serious on beans but rare in some western states. Leaf spots are at first very small, water-soaked or light green wilted areas, which enlarge, turn brown, are dry and brittle, and have a yellow border around edge of lesions and often a narrow, pale green zone outside that. Leaves become ragged in wind and rainstorms. Reddish brown horizontal streaks appear in stem, which may be girdled and break over at cotyledons or first leaf node.

Pod lesions are first dark green and water-soaked, then dry, sunken and brick red, sometimes with a yellowish encrustation of bacterial ooze. White seeds turn yellow, are wrinkled with a varnished look.

Control. Use disease-free western-grown seed. Keep away from beans when plants are wet.

Xanthomonas campestris pv. **pruni** (formerly *Xanthomonas pruni*). **Bacterial Spot** of stone fruits, also called canker, shot hole, black spot; general on plum, Japanese plum, prune, peach, and nectarine east of the Rocky Mountains; one of the more destructive stone fruit diseases, causing heavy losses in some states.

Symptoms on leaves are numerous, round or angular, small reddish spots with centers turning brown and dead, dropping out to leave shot holes. Spots may run together to give a burned, blighted, or ragged appearance, followed by defoliation, with losses running high in devitalized trees. On twigs dark blisters dry out to sunken cankers. Fruit spots turn into brown to black, saucer-shaped depressions with small masses of gummy, yellow exudate, often with cracking through the spot.

Control. Plant new orchards from nurseries free from the disease. Prune to allow air in the interior of trees. Feed properly; trees with sufficient nitrogen do not defoliate so readily. Zinc sulfate-lime sprays have been somewhat effective.

Xanthomonas campestris pv. **raphani** (formerly *Xanthomonas vesicatoria* var. *raphani*). **Leaf Spot** of radish, turnip, and other crucifers, similar to bacterial spot on tomato.

Xanthomonas campestris pv. **vesicatoria** (formerly *Xanthomonas vesicatoria*). **Bacterial Spot** of tomato and pepper, common in wet seasons. Small, black, scabby fruit spots, sometimes with a translucent border, provide entrance points for secondary decay organisms. Small, dark greasy spots appear on leaflets and elongated black spots on stems and petioles. Bacteria are carried on seed.

Control. Rotate crops; destroy diseased vines. Spraying or dusting with copper may reduce infection. These may be combined with streptomycin.

Xanthomonas campestris pv. **vignicola** (formerly *Xanthomonas vignicola*). **Cowpea Canker** on cowpeas and red kidney beans, a destructive disease, first described in 1944. Beans are blighted; cowpea stems have swollen, cankerlike lesions,with the cortex cracked open and a white bacterial exudate. The plants tend to break over. Leaves, stems, pods, and seeds are liable to infection. Chinese Red cowpeas seem particularly susceptible, but the disease appears on other varieties.

Xanthomonas campestris pv. **vitians** (formerly *Xanthomonas vitians*). **Bacterial Wilt** and **Leaf Spot** of lettuce, **South Carolina Lettuce Disease**, wilting and rotting of lettuce leaves and stems. In early stages plants are lighter green than normal. Leaves may have definite brown spots coalescing to large areas or may wilt following stem infection. Use windbreaks to prevent injuries affording entrance to bacteria; also causes leaf spot of pepper and tomato.

Xanthomonas campestris pv. **zinniae**. **Leaf and Flower Spot** of zinnia.

Xanthomonas campestris pv. **zinniae** (formerly *Xanthomonas nigromaculans*). **Leaf Spot** on zinnia.

Xanthomonas carotae (see *Xanthomonas campestris* pv. *carotae*). **Bacterial Blight** of carrot.

Xanthomonas corylina (see *Xanthomonas campestris* pv. *corylina*). **Filbert Blight**, **Bacteriosis**, the most serious disease of filberts in the Pacific Northwest, known since 1913 from the Cascade Mountains west in Oregon and Washington.

Xanthomonas cucurbitae (see *Xanthomonas campestriis* pv. *cucurbitae*). Bacterial Spot on winter squash and pumpkin

Xanthomonas dieffenbachiae (see *Xanthomonas campestriis* pv. *dieffenbachiae*). Dieffenbachia Leaf Spot. Spots are formed on all parts of leaf blade except midrib, but not on petioles and stems.

Xanthomonas glycines (*phaseoli* var. *sojense*) (see *Xanthomonas campestris* pv. *glycines*). Bacterial Pustule of soybean, similar to regular bean blight but chiefly a foliage disease, present in most soybean areas, more severe in the South

Xanthomonas gummisudans (see *Xanthomonas campestris* pv. *gummisudans*). Bacterial Blight of Gladiolus.

Xanthomonas hederae (see *Xanthomonas campestris* pv. *hederae*). Bacterial Leaf Spot of English ivy.

Xanthomonas hyacinthi (see *Xanthomonas campestris* pv. *hyacinthi*). Hyacinth Yellows, yellow rot of Dutch hyacinth, occasionally entering the country in imported bulbs.

Xanthomonas incanae (see *Xanthomonas campestris* pv. *incanae*). Bacterial Blight of garden stocks causing, since 1933, serious losses on flower-seed ranches in California; also present in home gardens.

Xanthomonas juglandis (see *Xanthomonas campestris* pv. *juglandis*). Walnut Blight on English or Persian walnut, black walnut, butternut, Siebold walnut.

Xanthomonas oryzae (see *Xanthomonas campestris* pv. *oryzae*). Carnation Pimple reported from Colorado as caused by a new form of the rice blight organism. **Xanthomonas papavericola** (see *Xanthomonas campestris* pv. *papavericola*). Bacterial Blight of poppy on corn poppy and on Oriental, opium, and California poppies.

Xanthomonas pelargonii (see *Xanthomonas campestris* pv. *pelargonii*). Bacterial Leaf Spot of geranium (*Pelargonium*).

Xanthomonas pelargonii (see *Xanthomonas campestris* pv. *pelargonii*). Geranium Leaf Spot on *Pelargonium* spp.

Xanthomonas phaseoli (see *Xanthomonas campestris* pv. *phaseoli*). Bacterial Bean Blight, general and serious on beans but rare in some western states.

Xanthomonas pruni (see *Xanthomonas campestris* pv. *pruni*. Bacterial Spot of stone fruit, also called canker, shot hole, black spot; general on plum, Japanese plum prune, peach, and nectarine east of the Rocky Mountains.

Xanthomonas vesicatoria (see *Xanthomonas campestris* pv. *vesicatoria*. Bacterial Spot of tomato and pepper, common in wet seasons.
Xanthomonas vesicatoria var. **raphani** (see *Xanthomonas campestris* pv. *raphani*). Leaf Spot of radish, turnip, and other crucifers, similar to bacterial spot on tomato.
Xanthomonas vignicola (see *Xanthomonas campestris* pv. *vignicola*). Cowpea Canker on cowpeas and red kidney beans.
Xanthomonas vitians (see *Xanthomonas campestris* pv. *vitians*). Bacterial Wilt and Leaf Spot of lettuce, South Carolina Lettuce Disease, wilting and rotting of lettuce leaves and stems.
Xanthomonas nigromaculans (see *Xanthomonas campestris* pv. *zinniae*). Leaf Spot on zinnia.
Xylella fastidiosa. Bacterial Leaf Scorch on maple, pecan, mulberry, northern red oak and sweet gum.
Pierce's Grape Disease. First described as California vine disease by Pierce in 1892, now known as cause of grape degeneration in Gulf states; reported from Rhode Island. First symptoms are scalding and browning of leaf tissues, often with veins remaining green; canes die back from tips in late summer; growth is dwarfed, fruit shriveled; roots die. The bacterium invades the xylem and turns it brown. Alfalfa plants are stunted with short stems and small leaves. Many species of sharpshooter leafhoppers transmit the bacterium to grape from alfalfa, clovers, grasses, also from ivy, acacia, fuchsia, rosemary, zinnia, and other ornamentals that are symptomless carriers. There is no adequate control; roguing of diseased vines and spraying for leafhoppers has proved ineffective. Propagate by cuttings from disease-free vineyards.

Mycoplasmataceae

Phytoplasma

Ash Yellows and **Witches' Broom**. On ash in Michigan, Montana, Nebraska, North Carolina, and South Dakota and peanut in Oklahoma.
Aster Yellows. Throughout the United States, also called Lettuce Rio Grande Disease, Lettuce White Heart, Potato Purple Top.
Bean Phyllody. Perhaps caused by a strain of aster-yellows MLO.
California Aster Yellows. In the West, also known as Celery Yellows, Western.

Aster Yellows, Potato Late Break, Strawberry Green Petal. Aster yellows may appear in more than 170 species of 38 families of dicotyledons. It is serious on China aster, may also affect anemone, calendula, coreopsis, cosmos, purple coneflower (Echinacea), delphinium, daisies, golden-glow, hydrangea, marigold, petunia, phlox, scabiosa, strawflower, and other flowers. It is serious on lettuce, alfalfa, endive, carrot, parsley, New Zealand spinach, radish, and some other vegetables, but not on peas, beans, or other legumes. This disease is now known to be caused by a phytoplasma organism.

In most plants vein clearing is followed by chlorosis of newly formed tissues, adventitious growth, erect habit, virescence of flowers. Asters have a stiff yellow growth with many secondary shoots; are stunted, with short internodes; flowers are greenish, dwarfed, or none. The chief vector is the six-spotted leafhopper (*Macrosteles fascifrons*). The virus multiplies in the insect, and there is a delay of 10 days or more after the insect feeds on a diseased plant before it can infect a healthy specimen. There is no transmission through insect eggs or aster seeds.

Celery petioles are upright, somewhat elongated, with inner petioles short, chlorotic, twisted, brittle, often cracked, yellow. The celery strain of the virus causes yellowing and stunting of cucumber, squash, pumpkin; infects gladiolus and zinnia.

Control of aster yellows is directed against the leafhoppers. Asters are grown commercially under frames of cheesecloth, 22 threads to the inch, or wire screening, 18 threads to the inch. In home gardens all diseased plants should be rogued immediately and overwintering weeds, which harbor leafhopper eggs, destroyed. Spraying or dusting ornamentals and vegetables with pyrethrum will reduce the number of vectors but will not entirely eliminate the disease.

Recent work raises the probability that the etiological agent of aster yellows is a mycoplasma rather than a virus. Therefore, treatment with antibiotics, such as chlortetracycline, has suppressed the development of yellows symptoms. Mycoplasma-like bodies have been seen in microscopic study of diseased plants and in transmitting leafhopper vectors, but not in healthy plants or nontransmitting vectors.

Clover Proliferation. On strawberry and onion.

Corn Stunt. A dwarfing disease present primarily in the South; transmitted by leafhoppers. Mycoplasma-like bodies present; See *Spiroplasma citri*.

Elm Phloem Necrosis. On American elm from West Virginia and Georgia to northern Mississippi, eastern Oklahoma, Kansas, and Nebraska. Origin

unknown but apparently present since 1882; the disease reached epidemic proportions in Ohio in 1944, killing 20,000 trees that year near Dayton and 10,000 at Columbus. The most reliable diagnostic character is a buttercup yellow discoloration of the phloem, often flecked with brown or black and an odor of wintergreen. Destruction of phloem causes the bark to loosen and fall away. Roots die first, then the phloem in lower portions of tree, followed by wilting and defoliation. American elms may be attacked at any age; they wilt and die suddenly within 3 or 4 weeks or gradually decline for 12 to 18 months. This is now thought to be caused by a mycoplasma-like agent.

Transmission is by the white-banded elm leafhopper (*Scaphoideus luteolus*) and possibly other species. Nymphs hatch about May 1 from eggs wintered on elm bark and feed on leaf veins. Adults move from diseased to healthy trees.

There is hope of propagating elms resistant to phloem necrosis. Communities should interplant existing elms with Asiatic or European varieties or with some other type of tree to provide shade if and when present elms die.

Peach Western X-Disease. Perhaps same as X-disease but usually treated separately; also known as cherry buckskin and western-X little cherry. The pathogen is transmitted by leafhoppers (*Colladonus germinatus, Fieberella florii, Osbornellus borealis*, and others) to peach, nectarine and cherry in western states. Symptoms vary according to rootstock, but cherry fruit is smaller than normal. Sour cherries are puttylike, pinkish; sweet cherries are small, conical, hang on trees late, fail to develop normal color. Symptoms on peach are similar to those of X-disease.

Peach X-Disease. On peach and chokecherry, sometimes cherry in the northern United States and of major importance in Connecticut, Massachusetts, and New York. Peach trees appear normal in spring for 6 or 7 weeks after growth starts, then foliage shows a diffused yellow and red discoloration with a longitudinal upward curling of leaf edges; spots may drop out, leaving a tattered effect. Defoliation starts by mid-summer. Fruits shrivel and drop or ripen prematurely. Seed do not develop. Weakened trees are killed by low temperatures or remain unproductive.

Chokecherry has conspicuous premature reddening of foliage, dead embryos in fruit. The second and third seasons after infection foliage colors are duller, there are rosettes of small leaves on terminals, and death may follow. Natural infection is apparently from chokecherry to peach (not peach to peach or peach to chokecherry) by a leafhopper (*Colladonus clitellarius*). Elimination of chokecherries within 500 feet of peach trees provides the best control.

Peach Yellow Leaf Roll; a form of Western X-Disease; perhaps caused by a more severe strain of the MLO.

Peach Yellows; Little Peach. First noted near Philadelphia in 1791 and so serious that in 1796 the American Philosophical Society offered a $60 prize for the best method of preventing premature decay of peach trees. Present in eastern states on peach, almond, nectarine, apricot and plum. Not found west of the Mississippi or in the South. In peach, clearing of veins, production of thin erect shoots with small chlorotic leaves, premature ripening of fruit (with reddish streaks in flesh and insipid taste) is followed by death of the tree in a year or so. The little peach strain of the MLO causes distortion of young leaves at tips of branches, small fruit, delayed ripening. Plum is systemically infected, with few obvious symptoms. Transmission is by the plum leafhopper or budding.

Control. Budsticks and dormant nursery trees can be safely treated with heat sufficient to kill the MLO (122°F for 5 to 10 minutes), but cured trees are susceptible to reinfection. Most effective control is removal of wild plum trees around peach orchard and spraying to control leafhoppers.

Potato Apical Leaf Roll and **Arizona Purple Top Wilt**. Caused by aster yellows.

Strawberry Green Petal. Perhaps due to a strain of aster yellows MLO, as is chlorotic phyllody reported from Louisiana. Flowers have enlarged sepals, small green petals.

Bud Proliferation and **Delayed Maturity**, on soybean.

Decline of ash.

Lethal Yellowing on palms.

Phloem Necrosis of chrysanthemum.

Spiroplasma citri. Corn Stunt. Has been reported on corn, onions, horseradish, shepherd's purse, yellow rocket, and wild mustard.

Stunt of blueberry.

Virescence on horseradish.

Witches' Broom on pigeon pea (*Cajanus cajan*), and black raspberry.

Witches' Broom on Japanese persimmon, and lilac.

Witches' Broom and **Yellowing** on annual statice.

Yellows of elm.

BLACK KNOT

The term black knot is used to designate a disease with black knotty excrescences.

Apiosporina

Ascomycetes, Pleosporales

Asci are in locules, without well-marked perithecial walls, immersed in a massive, carbonaceous stroma, erumpent and superficial at maturity. Spores are hyaline, unequally two-celled.

Apiosporina morbosa (formerly *Dibotryon morbosum*). **Black Knot** of plum and cherry, **Prunus Black Knot**, **Plum Wart**, widespread and serious on garden plums, also present on sweet and sour cherries, chokecherry, and apricot. Apparently a native disease, destructive in Massachusetts by 1811 and the pathogen described from Pennsylvania in 1821, black knot has been reported on peach, long thought to be immune.

The chief symptoms are black, rough, cylindrical or spindle-shaped enlargements of twigs into knots two to four times their thickness and several inches long (see Fig. 3.6). Infection takes place in spring, but swelling is not evident until growth starts the following spring, at which time the bark ruptures, and a light yellowish growth fills the crevices. In late spring this is covered with an olive green, velvety layer made up of brownish conidiophores and one-celled hyaline conidia of the anamorph *Hormodendron* state. Conidia are spread by wind.

In late summer black stromata cover the affected tissues, and the galls become hard. Asci are formed during the winter in cavities in the stroma; ascospores are discharged and germinate in early spring, completing the 2-year cycle. Knots are produced from primary infection by ascospores or from secondary infection from mycelium formed in old knots and growing out to invade new tissue. Limbs may be girdled and killed; trees are stunted

Figure 3.6 Black Knot on *Prunus* sp

and dwarfed, nearly worthless after a few years. Old knots may be riddled with insects or covered with a pink fungus growing on the *Apiosporina* mycelium.

Control. Cut out infected twigs and branches, 3 or 4 inches beyond the knot, to include advancing perennial mycelium. Do this in winter or before April 1. Eradicate or thoroughly clean up wild plums and cherries in the vicinity. Spray at delayed dormant stage in spring (just as buds break) with bordeaux mixture or with liquid lime sulfur. The latter is preferable unless oil is combined in the spray as an insecticide. Spray with lime sulfur at full bloom.

Dibotryon morbosum (see *Apiosporina morbosa*). **Black Knot** of plum and cherry, **Prunus Black Knot**, **Plum Wart**, widespread and serious on garden plums, also present on sweet and sour cherries, chokecherry, and apricot.

Leptosphaeria

Ascomycetes, Dothideales

Perithecia in clusters on wood; spores dark, with several cells.

Gibberidea heliopsidis (see *Leptosphaeria heliopsidis*). **Black Knot**, **Black Patch** on goldenrod and sunflower.

Leptosphaeria heliopsidis (formerly *Gibberidea heliopsidis*). **Black Knot**, **Black Patch** on goldenrod and sunflower.

BLACKLEG

The term blackleg is used to describe darkening at the base of a stem or plant. Blackleg of potatoes and delphinium are described under Bacterial Diseases; blackleg of geraniums is under Rots.

Cylindrocarpon

► Rots.

Cylindrocarpon obtusisporum. Blackleg; on grape.

Phoma

Deuteromycetes, Coelomycetes

Pycnidia dark, ostiolate, lenticular to globose, immersed in host tissue, erumpent or with short beak piercing the epidermis; conidiophores short or obsolete, conidia small, one-celled, hyaline, ovate to elongate; parasitic on seed plants, chiefly on stems and fruits, rarely on leaves.

Phoma lingam. Blackleg of crucifers, Foot Rot, Phoma Wilt of plants of the mustard family, including cabbage, cauliflower, Chinese cabbage, brussels sprouts, charlock, garden cress, pepper grass, kale, kohlrabi, mustard, rape, radish, rutabaga, turnip, stock, and sweet alyssum. The teleomorph state, *Lystosphaeria maculans* has been found on cabbage.The fungus was first noticed in Germany in 1791; the disease was reported in France in 1849, and in the United States in 1910. It is generally distributed east of the Rocky Mountains and formerly caused from 50 to 90% loss. With improved seed and seed treatment it has become less important.

The first symptom is a sunken area in the stem near the ground, which extends until the stem is girdled and the area turns black. Leaves, seed stalks, and seed pods have circular, light brown spots. Small black pycnidia appear-

ing on the lesions distinguish blackleg from other cabbage diseases. The leaves sometimes turn purple and wilt, but there is no defoliation, as in black rot.

The fungus reaches the soil via infected plant debris, remaining alive 2 or more years. Spores are spread by splashing rain, or manure, on tools, and perhaps by insects, with new lesions resulting in 10 to 14 days. But the chief spread is by mycelium wintering in infected seed. When such seed is planted, fruiting bodies are formed on cotyledons as they are pushed above ground, and these serve as a source of inoculum for nearby plants. A few diseased seed can start an epiphytotic in wet weather.

Control. Use seed grown on the Pacific Coast, which is usually, although not always, disease-free. If the seed is infected, tie loosely in cheesecloth bags and immerse in hot water, held at 122°F for 30 minutes. It is sometimes possible to buy seed already treated. Sterilize soil for the seedbed; use a 3-year rotation; do not splash seedlings when watering; do not transplant any seedlings if the disease shows up in the seedbed; do not feed cabbage refuse to cattle; do not transfer cultivators and other tools from a diseased to a healthy field without using a disinfestant.

Leptosphaeria

Leptosphaeria maculans. Blackleg on canola.

BLACK MILDEW

The terms black mildew, sooty mold, and black spot have been used to some extent interchangeably. In this text the term sooty mold is restricted to those fungi living on insect exudate and hence not true parasites. Included here under Black Mildew are parasitic fungi that have a superficial dark mycelium. They are members of the Erysiphales (Meliolales according to some classifications) and hence similar to powdery mildews except for the dark color, or they belong to the Hemisphaeriales, characterized by a dark stroma simulating the upper portion of a perithecium. In a few cases the diseases are called black spot rather than mildew.

Apiosporina

Ascomycetes, Pleosporales

Perithecia and mycelium superficial; mycelium with setae and perithecia usually hairy; paraphysoids present; spores two-celled; dark.

Apiosporina collinsii. **Witches' Broom** of serviceberry (*Amelanchier*) widespread. Perennial mycelium stimulates the development of numerous stout branches into a broom. A sooty growth on underside of leaves is first olive brown, then black. Numerous globose, beadlike, black perithecia appear in late summer. The damage to the host is not serious.

Asterina

Ascomycetes, Asterinales

Asterina species are parasites on the surface of leaves and are usually found in warm climates. In some cases the disease is called black mildew, in others, black spot. The perithecia are dimidiate, having the top half covered with a shield, a small, round stroma composed of radially arranged dark hyphae. Underneath this stromatic cover, called scutellum, there is a single layer of fruiting cells; paraphyses are lacking; spores are dark, two-celled. The mycelium, which is free over the surface, has lobed appendages,

hyphopodia, which act as haustoria in penetrating the cuticle and obtaining nourishment from the host.

Asteridium lepidigenum (formerly *Asterina lepidigena*). **Black Mildew** on lyonia, Florida.
Asterina anomala (see *Limacinula anomala*). **Black Mildew** on California-laurel, California.
Asterina delitescens. **Black Spot** on redbay.
Asterina diplopoides. **Black Spot** on leucothoë.
Asterina gaultheriae (see *Schizothyrium pomi*). **Black Mildew** on bearberry, Wisconsin.
Asterina lepidigena (see *Asteridium lepidigenum*). **Black Mildew** on lyonia, Florida.
Asterina orbicularis. **Black Spot** on American holly and *Ilex* spp.
Limacinula anomala (formerly *Asterina anomala*). **Black Mildew** on California-laurel, California.
Schizothyrium pomi (formerly *Asterina gaultheriae*). **Black Mildew** on bearberry, Wisconsin.

Asterinella

Ascomycetes, Asterinales

Like *Asterina* but lacking hyphopodia; with or without paraphyses; spores dark, two-celled.

Asterinella puiggarii. **Black Spot** on eugenia.

Dimerosporium

According to some authorities this is the same as *Asterina* but the name *Dimerosporium* is in common use.
Dimerosporium abietis (see *Rasutoria abietiis*). **Black Mildew** on Pacific silver and lowland white firs.
Dimerosporium hispidulum. **Black Mildew** on boxelder.
Dimerosporium pulchrum. **Black Mildew** on ash.
Dimerosporium robiniae. **Black Mildew** on ailanthus.
Dimerosporium tropicale. **Black Mildew** on bignonia, Mississippi.

Rasutoria abietiis (formerly *Dimerosporium abietis*). **Black Mildew** on Pacific silver and lowland white firs. Black patches are formed on older needles, usually on under surface. There is no apparent injury to trees.

(Irene) Asteridiella

Ascomycetes, Meliolales

Mycelium with capitate hyphopodia but no bristles; perithecia with larviform appendages; spores dark, with several cells.

Appendiculella araliae (formerly *Irene araliae*). **Black Mildew** on magnolia, Mississippi.
Appendiculella calostroma (formerly *Irene calostroma*). **Black Mildew** on wax-myrtle, Gulf States.
Appendiculella perseae (formerly *Irene perseae*). **Black Mildew** on avocado, Florida.
Like *Irene* except that perithecia have no appendages.
Asteridiella manca (formerly *Irenina manca*). **Black Mildew** on wax-myrtle, Mississippi.
Irene araliae (see *Appendiculella araliae*). **Black Mildew** on magnolia, Mississippi.
Irene calostroma (see *Appendiculella calostroma*). **Black Mildew** on wax-myrtle, Gulf States.
Irene perseae (see *Appendiculella perseae*). **Black Mildew** on avocado, Florida.
Irenina manca (see *Asteridiella manca*). **Black Mildew** on wax-myrtle, Mississippi.

Lembosia (Morenoella)

Ascomycetes, Dothideales

Brown vegetative mycelium with hyphopodia on surface of host; linear stroma, scutellum, over single layer of fruiting cells; paraphyses present; spores dark, two-celled.

Echidnodella angustiformis (formerly *Morenoella angustiformis*). **Black Mildew** on holly (*Ilex* spp.), Mississippi.
Echidnodella rugispora (formerly *Lembosia rugispora*). **Black Mildew** on redbay, swampbay, Mississippi, North Carolina.

Lembosia cactorum. **Black Mildew** on cactus, Florida.
Lembosia coccolobae. **Black Mildew** on sea-grape, Florida; also *L. portoricensis* and *L. tenella*.
Lembosia illiciicola. **Black Mildew** on anise-trees, Alabama, Mississippi.
Lembosia rugispora (see *Echidnodella rugispora*). **Black Mildew** on redbay, swampbay, Mississippi, North Carolina.
Morenoella angustiformis (see *Echidrodella angustiformis*). **Black Mildew** on holly (*Ilex* spp.), Mississippi.
Schiffnerula pulchra. On dogwood.

Meliola

Ascomycetes, Erysiphales (or Meliolales), Meliolaceae

Most abundant in tropics. Superficial dark mycelium with hyphopodia and setae; perithecia globose, coal black without ostiole or appendages but often with setae; spores several-celled, dark; paraphyses lacking. Conidia are lacking in most species, of *Helminthosporium* type in others.

Diplotheca tunae (formerly *Meliola wrightii*). **Black Mildew** on chinaberry.
Irenopsis cryptocarpa (formerly *Meliola cryptocarpa*). **Black Mildew** on gordonia.
Irenopsis martiniana (see *Meliola martiana*). **Black Mildew** on redbay, swampbay, Alabama, Florida, Mississippi.
Meliola amphitricha. **Black Mildew** on boxelder, magnolia, redbay, swampbay.
Meliola bidentata. **Black Mildew** on bignonia.
Meliola camelliae. **Black Mildew** of camellia. Abundant black growth may cover camellia leaves and twigs. Spraying with a light summer oil is sometimes effective.
Meliola cookeana. **Black Mildew** on callicarpa, lantana.
Meliola cryptocarpa (see *Irenopsis cryptocarpa*). **Black Mildew** on gordonia.
Meliola lippiae. **Black Mildew** on lippia.
Meliola magnoliae. **Black Mildew** on magnolia.
Like *Irene* except that mycelium has setae (stiff bristles) and perithecia lack larviform appendages.

Meliola martiana (formerly *Irenopsis martiniana*). **Black Mildew** on redbay, swampbay, Alabama, Florida, Mississippi.
Meliola nidulans. **Black Mildew** on blueberry, wintergreen.
Meliola palmicola. **Black Mildew** on palmetto.
Meliola tenuis. **Black Mildew** on bamboo.
Meliola wrightii (see *Diplotheca tunaei*). **Black Mildew** on chinaberry.

Sthughesia

Ascomycetes, Dothideales

Perithecia smooth; spores two-celled, dark; paraphyses lacking.

Dimerium juniperi (see *Sthughesia juniperi*). **Black Mildew** on Rocky Mountain juniper, California.
Sthughesia juniperi (formerly *Dimerium juniperi*). **Black Mildew** on Rocky Mountain juniper, California.

BLACKSPOT

In common usage the term black spot without qualifying adjectives has come to mean but one disease, rose black spot, with the two words currently written as one, blackspot. This section is limited to the rose disease. Delphinium black spot will be found under Bacterial Diseases, elm black spot under Leaf Spots, other black spots under Black Mildew.

Diplocarpon

Ascomycetes, Helotiales, Dermateaceae (Mollisiaceae)

Apothecia innate, formed in dead leaves, but at maturity rupturing overlying tissues; horny to leathery with a thick margin or outer wall (excipulum) of dark, thick-walled cells; spores two-celled, hyaline; paraphyses present. Anamorph state is a *Marssonina* with two-celled hyaline spores in an acervulus.

Diplocarpon rosae. Rose Blackspot, general on rose but less serious in the semi-arid Southwest; reported from all states except Arizona, Nevada, and Wyoming.

For nearly 100 years the fungus was known only by its anamorph state, which has had about 25 different names. The first definite record is by Fries in Sweden in 1815, under the name *Erysiphe radiosum*, but the first valid description was by Libert in 1827 as *Asteroma rosae*. Later Fries called it *Actinonema rosae*, and that term was widely used until *Actinonema* species were transferred to *Marssonina*. The blackspot fungus was first reported in the United States in 1831, from Philadelphia, and in 1912 Wolf made the connection with the teleomorph state, so that the correct name became *Diplocarpon rosae*.

Blackspot is probably the most widely distributed and best known rose disease. It is confined to roses, garden and greenhouse, and may affect practically all varieties, although not all are equally susceptible. There has been some progress made in breeding resistant varieties, but recent investigation

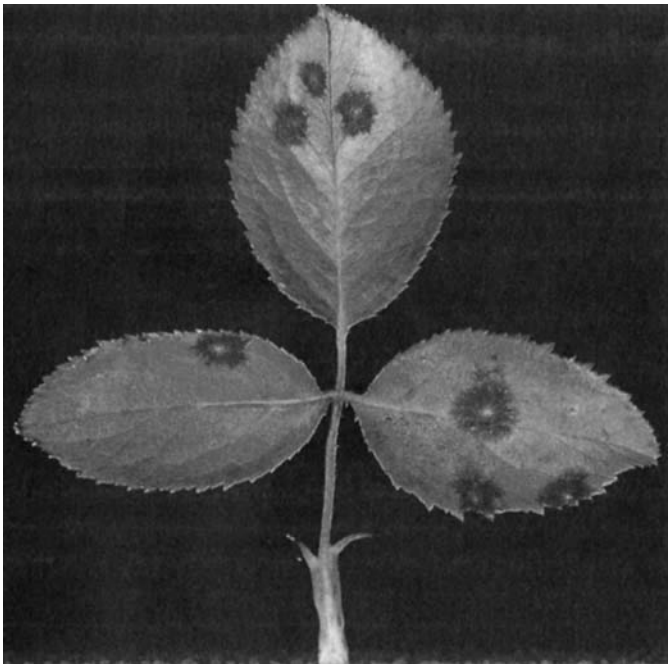

Figure 3.7 Rose Blackspot. Note fimbriate margin to spot

disclosing many physiological races of the fungus explains why roses that are almost immune to blackspot in one location may succumb in another. *Rosa bracteata* is the only species thus far shown to be reasonably resistant to all the different races tested. Roses with the Pernetiana parentage, which has given us the lovely yellows, coppers, and blends, are especially prone to blackspot. Some roses, like Radiance, are tolerant of blackspot, usually holding their leaves, even though they cannot be considered resistant.

Symptoms are primarily more or less circular black spots, up to 1/2 inch in diameter, with radiating fimbriate or fringed margins (see Fig. 3.7). This fimbriate margin is a special diagnostic character, differentiating blackspot from other leaf spots and from discolorations due to cold or chemicals. The spots vary from one or two to a dozen or more on a leaf, usually on the upper surface. With close examination you can see small black dots or pimples in the center of the spots. These are the acervuli, bearing conidia, and they glisten when wet (see Fig. 3.8).

In susceptible varieties the appearance of black spots is soon followed by yellowing of a portion or all of leaflets and then by defoliation. The leaf

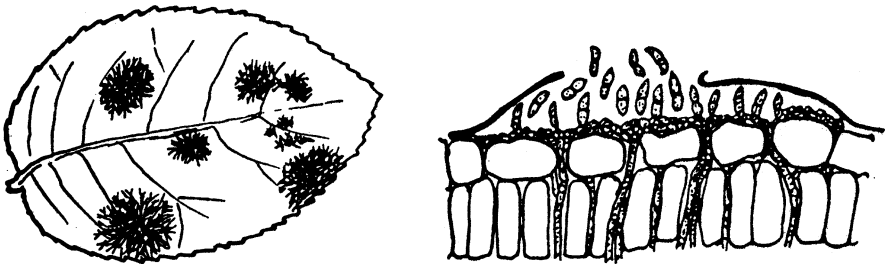

Figure 3.8 Rose Blackspot. Two-celled conidia formed in Acervulus under cuticle

fall is apparently correlated with increased production of ethylene gas in diseased tissue and perhaps by a difference in auxin gradient between leaf and stem. Some roses lose almost all their leaves, put out another set and lose those, and often are trying to leaf out for the third time by late summer. The process is so devitalizing that some bushes may die during the following winter. On tolerant varieties leaf spots are present, though usually in smaller numbers, but there is much less yellowing and defoliation. Cane lesions are small indistinct black areas, slightly blistered, without fimbriate margins.

Infection occurs through either leaf surface, the fungus sending its germ tube directly through the cuticle by mechanical pressure. The hyphae form a network under the cuticle, joining together into several parallel filaments radiating from the point of infection. The hyphae are actually colorless, the black color of the spot coming from the death and disorganization of host cells. The mycelial growth is between cells, with haustoria (suckers) invading epidermal and palisade cells for nourishment.

Acervuli, summer fruiting bodies, formed just under the cuticle, bear two-celled hyaline conidia on short conidiophores on a thin, basal stroma. Splashed by rain or overhead watering, or spread by gardeners working among wet plants, the conidia germinate and enter a leaf if there is continued moisture for at least 6 hours. Rain, heavy dew, fog, and sprinklers used late in the day so foliage does not dry off before night provide the requisite moisture. New spots show up within a week and new spores within 10 days. Secondary cycles are repeated all summer – from late May to late October around New York City.

In my personal experience, the spread of disease is most rapid where large numbers of susceptible varieties are massed together. If all the yellows, for

instance, are planted together, the disease gets such a head start, and builds up so much inoculum to spread to the more tolerant red and pink varieties nearby, that these varieties also are more heavily infected than usual. When roses are mixed in beds so that one or two particularly susceptible bushes are surrounded by more resistant types, the infective material cannot increase so rapidly, and the net result is less disease in the garden as a whole. Protected corners in the garden where air circulation is poor also increase the disease potentiality. Spores are apt to be splashed farther when water hits hard-packed soil without a mulch.

When old leaves drop to the ground, the mycelium continues a saprophytic existence, growing through dead tissue with hyphae that are now dark in color. In spring three types of fruiting bodies may be formed: microacervuli or spermagonia containing very small cells that perhaps act as male cells; apothecia, the sexual fruiting bodies formed on a stroma between the epidermis and palisade cells and covered with a circular shield of radiating strands; and winter acervuli, formed internally and producing new conidia in spring. The *Diplocarpon* or apothecial stage is apparently not essential; it is known only in northeastern United States and south-central Canada. The shield over the apothecium ruptures, and the two-celled ascospores are forcibly discharged into the air to infect lowest leaves.

Where the sexual stage is not formed, primary spring infection comes from conidia splashed by rain to foliage overhead, from acervuli either in overwintered leaves on the ground or in cane lesions. New roses from a nursery sometimes bring blackspot via these cane lesions to a garden previously free of disease.

Control. The importance of sanitation may have been somewhat overstressed; it cannot replace routine spraying or dusting. It is certainly a good idea to pick off for burning the first spotted leaves, if this is done when bushes are dry so that the act of removal does not further spread the fungus. Raking up old leaves from the ground at the end of the season makes the garden neater and may reduce the amount of inoculum in spring, but, because the fungus winters also on canes in most sections of the country, removal of leaves cannot be expected to provide a disease-free garden the next season. Comparative tests have shown that fall cleanup is ineffectual. A good mulch, applied after uncovering and the first feeding in spring, serves as a mechanical barrier between inoculum from overwintered leaves on the ground and developing leaves overhead. A mulch also reduces disease by reducing the distance spores can be splashed from one bush to another

during the season. Drastic spring pruning, far lower than normal, reduces the amount of inoculum from infected canes.

The importance of a dormant spray is debatable. Experiments have shown that as a true eradicant, applied in winter, it has little value in reducing the amount of blackspot the next summer. Use liquid lime sulfur after pruning, provided the buds have not broken far enough to show the leaflets.

Summer spraying or dusting, weekly throughout the season (from late April to early November in New Jersey) is essential if you want to keep enough foliage on bushes for continuous production of fine flowers (it takes food manufactured in several leaves to produce one bloom) and for winter survival. Some strong varieties will, however, live for years without chemical treatment; they are usually scraggly bushes with erratic bloom. The idea that floribunda varieties do not require as much spraying as hybrid teas is a misconception. Some floribundas are quite resistant; others are very susceptible. The same holds true for old-fashioned shrub roses. All too often blackspot gets a head start in a garden from shrub roses we thought it unnecessary to spray.

Roses can be defoliated as readily by chemicals as by the blackspot fungus; so the fungicide chosen must be safe under the conditions of applications as well as effective. There are many chemicals that will control blackspot if they are applied regularly and thoroughly. Choice depends somewhat on climate. Some copper sprays and dusts cause red spotting and defoliation in cool, cloudy weather. Bordeaux mixture is both unsightly and harmful, unless used in very weak dilution. At strengths recommended for vegetables it will quickly turn rose leaves yellow and make them drop off. Dusts containing more than 3 to 4% metallic copper are injurious under some weather conditions. Dusting sulfur fine enough to pass through a 325-mesh screen has been successfully used for years for blackspot control, but in hot weather it burns margins of leaves. Copper and sulfur have a synergistic effect; a mixture of the two is more effective than either used alone, but such a mixture also combines injurious effects.

There are literally hundreds of combination rose sprays and dusts on the market under brand names, and it seems to me easier, and even cheaper, considering the time saved, for home gardeners to make use of them to control blackspot and other rose diseases as well as insects in one operation. You will have to determine by trial and error the best combination for your area, and you may not find one that combines remedies for all the pests you may have to fight through the season. Choose one that contains ingredients required

every week all summer, and then add other chemicals if and when necessary. Whatever mixture is chosen, coverage should be complete on upper and lower leaf surfaces, and applications must be repeated at approximately weekly intervals. This may mean every 5 or 6 days when plants are growing rapidly in a rainy spring and perhaps every 7 to 9 days in dry weather, when growth is slow. Intervals of 10 to 14 days between sprays seldom give adequate control. Most directions call for application ahead of rain so that the foliage will be protected when spores germinate during the rain; but if sprays are applied every 7 days, there will always be enough residue left on the foliage to give protection during the next rain. It is not necessary to make an additional application immediately after a rain if your spraying is on a regular basis.

BLIGHTS

According to Webster, blight is "any disease or injury of plants resulting in withering, cessation of growth and death of parts, as in leaves, without rotting." The term is somewhat loosely used by pathologists and gardeners to cover a wide variety of diseases, some of which may have rotting as a secondary symptom. In general, the chief characteristic of a blight is sudden and conspicuous leaf and fruit damage, in contradistinction to leaf spotting, where dead areas are definitely delimited, or to wilt due to a toxin or other disturbance in the vascular system. Fire blight, discussed under Bacterial Diseases, is a typical blight, with twigs and branches dying back but holding withered, dead foliage.

Alternaria

Deuteromycetes, Hyphomycetes

Dark, muriform conidia formed in chains, simple or branches, or sometimes singly, on dark, simple conidiophores growing from dark hyphae (see Fig. 3.9). The apical portion of each conidium is narrowed and often elongated, bearing at its tip the next ovoid, tapering conidium. Species with this characteristic formerly placed in *Macrosporium* are now in *Alternaria*; those with spores rounded at both ends have been transferred to *Stemphylium*.

There are many saprophytic species in *Alternaria*, the spores of which are wind-borne for many miles and are a common cause of hayfever. There are also parasitic forms causing blights and leaf spots. Sometimes the disease starts as a leaf spot, but the lesions, typically formed in concentric circles, run together to form a blight, the dark conidia making the surface appear dark and velvety.

Alternaria alternata. **Blight, Foliage** and **Pod** of pea.

Alternaria cassiae. **Seedling Blight** of *Cassia* (sicklepod, and coffee senna), and showy crotalaria.

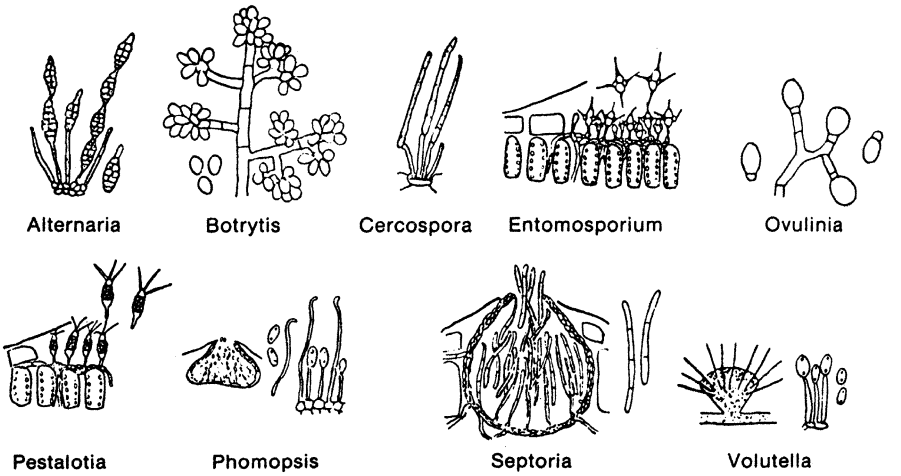

Figure 3.9 Conidial Production Among Some Fungi Causing Blights. *Alternaria*, dark muriform spores in chains; *Botrytis*, hyaline spores in clusters; *Cercospora*, pale to dark septate spores on dark conidia protruding from stomata; *Entomosporium*, peculiarly appendaged spores in acervulus; *Ovulina*, hyaline spore with basal disjunctor cell, borne free on mycelium; *Pestalotia*, in acervulus, median cells colored, end cells hyaline, apical cell with appendages; *Phomopsis*, oval and filiform hyaline spores in pycnidium; *Septoria*, septate hyaline spores in Pycnidium; *Volutella*, hyaline spores formed on a hairy sporodochium

Alternaria cucumerina. **Alternaria Blight** of Cucurbits, **Cucumber Blight**, **Black Mold**, general on cucumbers, muskmelon, watermelon, and winter and summer squash. Symptoms appear in the middle of the season, first nearest the center of the hill. Circular brown spots with concentric rings are visible only on upper surface of leaves, but a black, moldy growth, made up of conidiophores and large brown spores, can be seen on both leaf surfaces. Leaves curl and dry up, cantaloupe foliage being more sensitive than that of other cucurbits. The disease spreads rapidly in warm, humid weather, and, with the vines drying, the fruit is exposed to sunburn. Sunken spots develop on the fruit, covered with an olive green mass of conidia. Other species of *Alternaria* cause a decay of melons in transit and storage.

Control. Purdue 44 and some other varieties of muskmelon are rather resistant.

Alternaria dauci. **Alternaria Blight** of carrot, **Carrot Leaf Blight**, general on carrot and parsley. Affected leaves and petioles are spotted, then turn yellow and brown; entire tops are killed in severe infections. In California the disease is known as late blight, with the peak coming in November. The fungus apparently winters in discarded tops and on seed.

Control. Clean up refuse. Spray with a fixed copper spray or dust, starting soon after seedlings emerge and repeating at 7- to 10-day intervals.

Alternaria dianthicola. **Carnation Collar Blight**, **Leaf Spot**, **Stem and Branch Rot**, general on carnation, widespread on garden pinks and sweet william. The chief symptom is a blight or rot at leaf bases and around nodes, which are girdled. Spots on leaves are ashy white but centers of old spots are covered with dark brown to black fungus growth. Leaves may be constricted and twisted, the tip killed. Branches die back to the girdled area, and black crusts of spores are formed on the cankers. Conidia are spread during watering in the greenhouse or in rains, outdoors. Entrance is through wounds, stomata, or directly through the cuticle. The spores are carried on cuttings.

Control. Commercial growers can often avoid Alternaria blight by keeping plants growing continuously in the greenhouse. Cuttings should be disease-free, taken from midway up the stem, broken at the joint rather than cut, and started in sterilized soil. Ordinarily the foliage should be kept dry, but under mist propagation chemicals introduced into the mist system have reduced blight.

Alternaria helianthi. **Blight** and **Stem Lesion** of sunflower.

Alternaria panax. **Alternaria Blight**, **Root Rot**, **Leaf Spot** of ginseng, ming aralia, and goldenseal, generally distributed. In Ohio the disease appears each year in semiepidemic form and has been controlled with bordeaux mixture or a fixed copper spray plus a wetting agent, starting when plants emerge in early May and repeating every 2 weeks until 3 weeks after bloom.

Alternaria solani. **Early Blight** of potato and tomato, general on these hosts, occasional on eggplant and pepper. The pathogen was first described from New Jersey, in 1882.

Leaf symptoms are dark brown, circular to oval spots, marked with concentric rings in a target effect, appearing first on lower, shaded foliage, with the spots growing together to blight large portions or all of leaves, exposing fruits. There may be a collar rot of young tomato seedlings, sunken spots or cankers on older stems, blossom-drop with loss of young fruits, or dark leathery spots near the stem end of older fruits. Alternaria blight is the most common leaf spot disease of tomatoes in the Central and Atlantic States but is somewhat less important elsewhere.

Foliage symptoms on potato are similar to those on tomato. Small round spots on tubers afford entrance to secondary rot organisms. Each leaf spot may produce three or four crops of dark spores, which remain viable more

than a year. They are blown by wind, splashed by rain, sometimes transmitted by flea beetles. The fungus is a weak parasite, entering through wounds and thriving in warm, moist weather, with 85°F as optimum temperature. It can survive in soil as long as the host refuse is not completely rotted; it also winters on seed and on weed hosts.

Control. Plan, if possible, a 3-year rotation with crops not in the potato family; dig under diseased refuse immediately after harvest. Use seed from healthy tomatoes, or purchase plants free from collar rot.

Alternaria tagetica. **Blight** of marigold.

Alternaria tenuissima. **Alternaria Blight**, **Leaf Spot** of violet and pansy. Spots vary from greenish yellow to light buff with burnt amber margins. Brown patches run together to form large, blighted areas. Clean up and burn old leaves in fall.

Alternaria zinniae. **Zinnia Blight**, **Alternariosis** on zinnia. Small reddish brown spots with grayish white centers increase to irregular, large, brown, dry areas. Similar spots on stem internodes or at nodes may girdle the stem, with dying back of upper portions. Dark brown to black basal cankers with sunken lesions are common. Roots may turn dark gray, rot, and slough off. Small brown flower spots enlarge to include whole petals, causing conspicuous blighting. The fungus apparently winters on seed and in soil.

Control. Clean up refuse; use a long rotation if growing plants commercially.

Ascochyta

Deuteromycetes, Coelomycetes

Pycnidia dark, globose, separate, immersed in host tissue, ostiolate; spores two-celled, hyaline ovoid to oblong.

Ascochyta asparagina. **Stem Blight** of asparagus fern. Small branchlets dry and drop prematurely; small branches are killed if attacked at crown.

Ascochyta chrysanthemi (*Mycosphaerella ligulicola*). (see *Phoma chrysanthemi* (*Didymella ligulica*)). **Ascochyta Ray Blight** of chrysanthemum, a conspicuous and rapid disease of ray flowers.

Ascochyta fabae f. sp. **spiricia**. **Leaf Blight** of vetch.

Ascochyta piniperda. **Spruce Twig Blight** on young shoots of red, Norway, and blue spruce; apparently a minor disease.

Ascochyta pisi, **A. pinodes**, **A. pinodella**. **Ascochyta Blight** or **Mycosphaerella Blight** of peas. All three fungi may be connected with the dis-

ease complex known as Ascochyta blight, are carried in infected seed and overwinter in plant debris. *A. pinodes* has *Mycosphaerella pinodes* as its ascospore stage so that the life cycle can start from either pycnidia or perithecia produced on plants or stubble.

Lesions begin as small purplish specks on leaves and pods. When infection is caused by *M. pinodes* or *A. pinodella*, the specks enlarge to round, targetlike spots, which join together to form irregular, brownish purple blotches. *M. pinodes* often withers and distorts young pods; *A. pinodella* causes a severe foot rot, a dark region at the soil line. Elongated, purplish black stem lesions are common. *A. pisi* causes leaf spots with dark brown margins, stem and pod spots, but no foot rot.

Control. Use western-grown seed, usually free from the disease; clean up all pea refuse and use a 3- or 4-year rotation.

The host range now includes many plants such as carrot, banana, and foliage plants.

Phoma chrysanthemi (Telemorph, **Didymella ligulica**) (formerly *Ascochyta chrysanthemi* (telemorph, *Mycosphaerella ligulicola*)). **Ascochyta Ray Blight** of chrysanthemum, a conspicuous and rapid disease of ray flowers. If young buds are infected, the head does not open; if the attack is later, there may be one-sided development of flowers. A tan or brown discoloration proceeds from the base toward the tip of each individual flower, followed by withering. Upper portions of stems and receptacles may turn black. Keep plants well spaced; avoid overhead watering and excessive humidity.

Balansia

Ascomycetes, Hypocreales, Clavicipitaccae.

Balansia cyperi. **Diseased Inflorescence, Blight** of purple nutsedge; fungus is systemic and transmitted through tubers.

Beniowskia

Deuteromycetes, Hyphomycetes

Hyphae are coiled at the periphery of mature sporodochia; spherical spores are borne on short denticles.

Beniowskia sphaeroidea. **Blight** of knotroot bristlegrass.

Botryodiplodia

Deuteromycetes, Coelomycetes

Pycnidia black, ostiolate, erumpent, stromatic, confluent; conidiosphores simple, short; conidia dark and 2- celled, ovoid to elongate

Botryosphaeria

Ascomycetes, Dothideales

Asci in locules in a stroma; spores one-celled, hyaline, eight in an ascus. There is a good deal of variation in the genus. The locules may be scattered throughout the stromatic tissue, or seated on the surface, or like perithecia, as in *Botryosphaeria ribis*. In *B. ribis* there are two pycnidial forms, a *Dothiorella* stage containing very small spores that may function as male cells and a *Macrophoma* stage containing larger spores, one-celled, hyaline, functioning as other conidia.

Botryosphaeria ribis var. **chromogena**. **Current Cane Blight**, **Canker**, **Dieback** of currant, flowering currant, gooseberry, apple, rose, and many other plants (also ►Cankers). There are two forms of this species, one being a saprophyte developing on already dying tissue. The parasitic form *chromogena* is so named from its developing a purple-pink color when grown on starch paste. There are also a number of pathogenic strains, varying from high to low in virulence. Some currant varieties are quite resistant, but the widely grown Wilder and Red Lake are rather susceptible.

Dieback and death of fruiting branches occur as the berries are coloring, with leaves wilting and fruit shriveling. Later in the season small, dark, wartlike fruiting bodies appear in rather definite parallel rows on the diseased canes. Rose canes show a similar dying back and wilting above a canker. The fungus winters in the canes; ascospores infect new shoots; secondary infection is by spores oozing from pycnidia. The mycelium grows downward through bark and wood to the main stem, which it encircles and kills.

Control. Cut out and burn diseased canes as soon as noticed. Take cuttings from healthy bushes.

Botryotinia

Ascomycetes, Helotiales, Sclerotiniaceae

Stroma a typical black sclerotium, loaf-shaped or hemispherical, just on or beneath cuticle or epidermis of plant and firmly attached to it; apothecia cupulate, stalked, brown; ascospores hyaline, one-celled; conidiophores and conidia of the *Botrytis cinerea* type.

Botryotinia fuckeliana. The apothecial stage of *Botrytis cinerea*, the connection having been made with isolates from grape, apple, celery, and potato. The name of the conidial stage is still widely used for the pathogen causing gray mold blights.

Botryotinia ricini. **Gray Mold Blight** of castor bean, **Soft Rot** of caladium. A pale to olive gray mold develops on castor-bean inflorescence, and when fading flowers drop onto stem and leaves, they are infected in turn.

Botrytis

Deuteromycetes, Hyphomycetes

Egglike conidia hyaline, one-celled, are formed on branched conidiophores over the surface, not in special fruiting bodies (see Fig. 3.9). The arrangement of the spores gives the genus its name, from the Greek *botrys*, meaning a cluster of grapes. Flattened, loaf-shaped, or hemispherical black sclerotia are formed on or just underneath cuticle or epidermis of the host and are firmly attached to it. These sclerotia, with a dark rind and light interior made up of firmly interwoven hyphae, serve as resting bodies to carry the fungus over winter. Microconidia, very minute spores that are spermatia or male cells, function in the formation of apothecia in the few cases where a definite connection has been made between the *Botrytis* stage and the ascospore form, *Botryotinia*.

Botrytis species are the common gray molds, only too familiar to every gardener. Some are saprophytic or weakly parasitic on senescent plant parts on a wide variety of hosts; others are true parasites and cause such important diseases as peony blight, lily blight, tulip fire.

Botrytis cinerea. **Gray Mold Blight**, **Bud and Flower Blight** (see Fig. 3.10), **Blossom Blight**, **Gray Mold Rot**, **Botrytis Blight** of general distribution on a great many flowers, fruits and vegetables. There are undoubtedly many strains of this fungus and perhaps more than one species involved, but they have not been definitely separated.

This gray-mold disease is common on soft ripe fruits after picking, as any cook knows after throwing out half a box of strawberries or raspberries. But in continued humid weather the blight appears on fruits before harvest.

Figure 3.10 Botrytis Petal Spot on Magnolia

Blackberries in the Northwest are subject to gray mold. The fungus winters in blighted blueberry twigs, and spores infect blossom clusters.

Vegetables are commonly afflicted as seedlings grown in greenhouses and in storage after harvest. If lettuce plants are set in the garden too close together, they may blight at the base in moist weather, as will endive and escarole. Gray mold is common on lima beans, is sometimes found on snap and kidney beans. In rainy or foggy periods globe artichoke may be covered with a brownish gray, dusty mold, with bud scales rotten. Asparagus shoots are sometimes blighted, tomato stems rotted.

Some of the ornamentals on which *Botrytis cinerea* is troublesome are given in the following annotated list:

African violet – leaf and stem rot, cosmopolitan in greenhouses.

Amaryllis – gray mold, mostly in the South, on outdoor plants after chilling.

Anemone – occasional severe rotting of crowns.

Arborvitae – twig blight.
Aster – brown patches in flower heads of perennial aster; gray mold on flowers of China aster grown for seed in California.
Begonia – dead areas in leaves and flowers rapidly enlarging and turning black in a moist atmosphere; profuse brownish gray mold.
Calendula – gray-mold blight.
Camellia – flower and bud blight, common after frost.
Carnation – flower rot or brown spotting, worse in a cool greenhouse.
Century plant – gray mold after overwatering and chilling.
Chrysanthemum – cosmopolitan on flowers, buds, leaf tips, and cuttings. Ray blight on flowers starts as small, water-soaked spots, which rapidly enlarge with characteristic gray mold.
Dahlia – bud and flower blight.
Dogwood – flower and leaf blight. In wet springs anthers and bracts of aging flowers are covered with gray mold, and when these rot down on top of young leaves, there is a striking leaf blight.
Eupatorium – stem blight, common in crowded plantings. A tan area girdles stem near ground with tops wilting or drying to that point.
Geranium (*Pelargonium*) – blossom blight and leaf spot, most common in cool, moist greenhouses where plants are syringed frequently. Petals are discolored, flowers drop, gray mold forms on leaves.
Lily – *Botrytis cinerea* is common on lilies, but see also *B. elliptica*.
Marigold – gray mold prevalent on fading flowers.
Peony – late blight, distinguished from early blight (see *B. paeoniae*) by the sparse mold, usually standing far out from affected tissues, rather than a thick, short velvety mold, and by much larger, flatter sclerotia formed near base of the stalk. Late flowers are infected, and when they drop down onto wet foliage, irregular brown areas are formed in leaves.
Pine – seedling blight.
Pistachio – shoot blight.
Poinsettia – tip blight and stem canker.
Primrose – crown rot and decay of basal leaves, with prominent gray mold, very common in greenhouses where plants are heavily watered.
Rhododendron – flower, twig, and seedling blight.
Rose – bud or flower blight, cane canker. When half-open buds ball, the cause is often an infestation of thrips; but if gray mold is present, *Botrytis* is indicated. Canes kept too wet by a manure mulch, or wet leaves, or injured in some way, are often moldy.

Snapdragon – flower spikes wilt; tan cankers girdle stems.
Sunfiower – bud rot and mold.
Sweet pea – blossom blight.
Viola spp. – gray mold and basal rot of violet and pansy.
Zinnia – petal blight, head blight, moldy seed.
Botrytis cinerea may also infect arabis, cineraria, eucharis, euphorbia, fuchsia, gerbera, gypsophila, heliotrope, hydrangea, iris, lilac, lupine, May-apple, pyrethrum, periwinkle, rose-of-Sharon, stokesia, viburnum, and wallflower.
Control. Sanitation is more important than anything else. Carry around a paper bag as you inspect the garden; put into it all fading flowers and blighted foliage; if infection is near the base, take the whole plant up for burning. Keep greenhouse plants widely spaced, with good ventilation; avoid syringing, overhead watering, and too cool temperature. Propagate cuttings from healthy plants in a sterilized medium.
Botrytis douglasii. **Seedling Blight** of giant sequoia and redwood, perhaps a form of *B. cinerea*.
Botrytis elliptica. **Lily Botrytis Blight**, general on lilies, also reported on tuberose and stephanotis in California. Lily species vary in susceptibility to the disease, but there are several strains of the fungus, and few lilies are resistant to all strains. Madonna lily, *L. candidum*, is particularly susceptible, with infection starting in autumn on the rosette of leaves developed at that time.
If the blight strikes early, the entire apical growth may be killed with no further development. More often the disease starts as a leaf spot when stems are a good height. Spots are orange to reddish brown, usually oval. In some species there is a definite red to purple margin around a light center; in others the dark margin is replaced by an indefinite water-soaked zone. If spots are numerous, they grow together to blight the whole leaf. Infection often starts with the lowest leaves and works up the stem until all leaves are blackened and hanging limp. This is the result of many spot infections and not from an invasion of the vascular system.
Buds rot or open to distorted flowers with irregular brown flecks. There are sometimes severe stem lesions, but the rot rarely progresses into the bulbs. Spores formed in the usual gray-mold masses in blighted portions are spread by rain, air currents, and gardeners. Optimum spore germination is in cool weather, around 60°F, but once infection has started 70°F promotes most rapid blighting. With sufficient moisture the cycle may repeat every few days through the season. The fungus winters as very small black sclerotia, irregu-

lar or elliptical in shape, in fallen flowers or blighted dead stems and leaves, or as mycelium in the basal rosette of Madonna lilies.

Control. Avoid too dense planting, and shady or low spots with little air circulation and subject to heavy dews. Clean up infected plant parts before sclerotia can be formed. Copper sprays are more effective for the lily *Botrytis* than the newer organics. Spray with bordeaux mixture; start when lilies are 5 or 6 inches high and continue at 10- to 14-day intervals until flowering.

Botrytis galanthina. **Botrytis Blight** of snowdrop, sometimes found in the sclerotial state on imported bulbs. If the black dots of sclerotia are present only on outer scales, remove scales before planting; otherwise discard bulbs.

Botrytis gladiolorum. **Gladiolus Botrytis Blight**, **Corm Rot**, first reported in Oregon in 1939 and now serious in all important gladiolus-growing areas – the Pacific Coast, the Midwest, Florida – in cool, rainy weather. In northern areas the disease is a corm-rotting problem, in the South a flower blight, damaging in transit, and in all areas it is a leaf spot or blight.

In dry weather and in more resistant varieties the leaf spots are very small, rusty brown, appearing only on the exposed side of the leaf. In more humid weather the spots are large, brown, round to oval or smaller, pale brown with reddish margins. Flower stems have pale brown spots that turn dark. There may be a soft rotting at the base of florets. The disease starts on petals as pinpoint, water-soaked spots, but in moist weather the whole flower turns brown and slimy. Flowers with no visible spotting when packed often arrive ruined. After the flowers are cut, infection spreads down the stalk and into the corm, producing dark brown spots, irregular in shape and size, most numerous on the upper surface. Corms may become soft and spongy with a whitish mold. Oval, flat, black sclerotia, 1/8 to 1/4 inch long, are formed on corms in storage and in rotting tissue in the field or in refuse piles. They may persist in the soil several years.

Control. Cure corms rapidly after digging; bury or burn all plant refuse.

Botrytis hyacinthi. **Hyacinth Botrytis Blight** recently found in Washington on plants grown from imported bulbs. Leaves have brown tips with gray mold or brown spots on lower surface. Leaves may be killed, with small black sclerotia formed in rotting tissue. Flowers rot and are covered with powdery gray spores. Do not work with plants when they are wet; remove infected parts or whole plants.

Botrytis narcissicola. ► *Sclerotinia narcissicola*, under Rots.

Botrytis paeoniae. **Peony Botrytis Blight**, **Early Blight**, **Bud Blast**, **Gray Mold**, probably present wherever peonies are grown. It is also record-

ed on lily-of-the-valley, but that may be a form of *Botrytis cinerea*. Peony blight was first noticed in epiphytotic form in this country in 1897 and has been important in wet springs ever since.

Young shoots may rot off at the base as they come through the ground or when a few inches high, with a dense velvety gray mold on the rotting portions. This early shoot blight is far more common when the young stems are kept moist by having to emerge through a mulch of manure or wet leaves. Flowers are attacked at any stage. Buds turn black when they are very tiny, never developing, or they may be blasted when they are half open. If it is dry in early spring, infection may be delayed until flowers are in full bloom, at which time they turn brown. Infection proceeds from the flower down the stem for a few inches, giving it a brown and tan zoned appearance. Leaf spots develop when infected petals fall on foliage. Continued blighting of leaves through the summer and late blasting of flowers may be due to *Botrytis cinerea*, which produces a sparser mold and conidiophores projecting farther from the petal or leaf surface.

Conidia are blown by wind, splashed by rain, carried on gardeners' tools, and sometimes transported by ants. Secondary infection is abundant in cool moist weather. In late summer small, shiny black, slightly loaf-shaped sclerotia are formed near the base of stalks, just under the epidermis. They are quite different from the large, flat, black sclerotia often formed by *B. cinerea* on the same stalks.

Control. Sanitation is the most important step. Cut down all tops in autumn at ground level, or just below, to get rid of sclerotia wintering near base of stems. Burn this debris; never use it for a mulch. Avoid any moisture-retentive covering. If you insist on manure, apply it in a wide ring around the plant, well outside the area of emerging shoots. Go around with a paper bag periodically, cutting off for burning all blighted parts; never carry these parts loose through the garden for fear of shedding spores to healthy plants.

Botrytis polyblastis. ► *Sclerotinia polyblastis*.

Botrytis streptothrix (see *Streptobotrys arisaemae*) (teleomorph state *Streptotinia arisaemae*). **Leaf and Stalk Blight** of Jack-in-the-pulpit and golden club.

Botrytis tulipae. **Tulip Fire**, **Botrytis Blight** of tulips, general wherever tulips are grown, causing much damage in rainy springs. The first indication of disease is the appearance of a few malformed leaves and shoots among healthy tulips or large light patches resembling frost injury on leaves. Gray

Figure 3.11 Botrytis Blight on Tulip

mold forming on such blighted areas of plants grown from infected bulbs provides an enormous number of conidia to be splashed by rain to nearby tulips. Secondary infection appears as minute, slightly sunken, yellowish leaf spots, surrounded with a water-soaked area, and gray to brown spots on stems, often zonate, and resulting in collapse. Small white spots appear on colored flowers, brown spots on white petals (see Fig. 3.11); but with continued moisture the spots grow together, and in a day or so the fuzzy gray mold has covered rotten blooms and large portions of blighted leaves.

Very small, shiny black sclerotia are formed in leaves and petals rotting into the ground, or on old flower stems or bulbs. Sometimes the latter have yellow to brown, slightly sunken, circular lesions on outermost fleshy scales without the formation of sclerotia. Spring infection comes from spores produced on such bulbs or from sclerotia on bulbs or sclerotia left loose in the soil after infected tissues have rotted.

Control. Inspect all bulbs carefully before planting; discard those harboring sclerotia or suspicious brown lesions. It is wise, though seldom possible in a small garden, to plant new bulbs where tulips have not grown for 3 years. Plant where there is good air circulation. Make periodic inspections, starting early, removing into a paper bag plants with serious primary infection and blighted leaves. Cut off all fading flowers before petals fall; cut off all foliage at ground level when it turns yellow. Burn all debris.

Streptobotrys arisaemae (formerly *Botrytis streptothrix*) (teleomorph state *Streptotinia arisaemae*). **Leaf** and **Stalk Blight** of Jack-in-the-pulpit and golden club. This species has conidiophores with strikingly twisted branches, producing a reddish brown mat of conidia. Sclerotia are very small, seldom over 1/32 inch, black, shiny, and somewhat hemispherical.

Briosia

Deuteromycetes, Hyphomycetes

Conidia on synnemata or coremia, erect fascicles of hyphae ending in a small head; spores globose, dark, one-celled, catenulate (formed in chains).

Briosia azaleae (see *Pycnosystanus azalea*) (*Pycnostysanus azaleae*). **Bud and Twig Blight** of azalea and rhododendron, widespread but occasional.
Pycnosystanus azalea (formerly *Briosia azaleae*) (*Pycnostysanus azaleae*). **Bud and Twig Blight** of azalea and rhododendron, widespread but occasional. The disease was reported from New York in 1874 and, as a rhododendron bud rot, from California in 1920. It was particularly serious on Massachusetts azaleas in 1931 and 1939. Flower buds are dwarfed, turn brown and dry; scales are silvery gray. Twigs die when lateral leaf buds are infected. Successive crops of coremia are produced on old dead buds for as long as three years, the first crop appearing the spring after summer infection. The coremia heads are dark, and the buds look as if stuck with tiny, round-headed pins. Prune out and burn infected buds and twigs in late autumn and early spring. Spraying with bordeaux mixture before blossoming and at monthly intervals after bloom may be wise in severe cases.

Calonectria

►Cylindrocladium under Blights.
Calonectria colhounii. **Blight** on Leucospermum.

Cenangium

Ascomycetes, Helotiales

Apothecia small, brown to black, sessile or substipitate on bark; spores hyaline, elliptical, one-celled; paraphyses filiform.

Cenangium ferruginosum. **Pine Twig Blight**, **Pruning Disease**; **Cenangium Dieback** of fir and pine. The fungus is ordinarily saprophytic on native pines but may become parasitic when their vigor is reduced by drought. The disease is considered beneficial to ponderosa pine in the Southwest because it prunes off the lower branches; on exotic pines it can be damaging.

Infection starts near a terminal bud in late summer and progresses down a twig into a node, sometimes beyond into 2-year wood. The needles redden and die; they are conspicuous in spring but drop in late summer. Then brown to black apothecia with a greenish surface to the cup appear on twigs. Cut off and destroy infected twigs.

Cercospora

Deuteromycetes, Hyphomycetes

Conidia hyaline to pale to medium green or brown; long, usually with more than three cross walls; straight or curved, with the base obconate or truncate, tip acute to obtuse; thin-walled; not formed in a fruiting body but successively on slender conidiophores, which emerge in fascicles or groups from stomata and usually show joints or scars where conidia have fallen off successively. The conidiophores are always colored, olivaceous to brown, pale to very dark (Fig. 3.9).

This is the largest group of the Dematiaceae, with about 400 species, all parasitic, causing leaf spots or blights. The teleomorph state, when known, is *Mycosphaerella*.

Cercospora apii. **Early Blight** of celery, general on celery and celeriac, first noted in Missouri in 1884 and since found in varying abundance wherever celery is grown. The disease is most severe from New Jersey southward. The name is somewhat misleading; in Florida early blight rarely appears before the Septoria disease known as late blight. Foliage spots appear when plants are about 6 weeks old. Minute yellow areas change to large, irregular, ash gray lesions, covered in moist weather with velvety groups of conidiophores and spores on both sides of leaves. Sunken, tan, elongated spots appear on stalks just before harvest. The disease spreads rapidly in warm, moist weather, the spores being splashed by rain, carried with manure or cultivators, or blown by wind. The life cycle is completed in 2 weeks.

Control. Seed more than 2 years old is probably free from viable spores; other seed should be treated with hot water, 30 minutes at 118° to 120°F.

Bordeaux mixture and other copper sprays have been recommended. Spray applications should start soon after plants are set and be repeated weekly, or more often. Emerson Pascal is blight-resistant.

Cercospora carotae. **Early Blight** of carrot. Lesions on leaves and stems are subcircular to elliptic, pale tan to gray or brown or almost black; lobes or entire leaflets are killed. The disease is more severe on young leaves and builds up as the plant grows. Spores, produced on both leaf surfaces, are spread by wind.

Control. Rotate crops and clean up refuse.

Cercospora microsora. **Linden Leaf Blight**, general on American and European linden. Small circular brown spots with darker borders coalesce to form large, blighted areas, often followed by defoliation; most serious on young trees.

Cercospora sequoiae. **Arborvitae Blight**, **Fire Blight**, on oriental arborvitae and Italian cypress in the South; destructive in ornamental plants. First reported from Louisiana in 1943, the fungus was named as a new species of *Cercospora* in 1945, but it is nearer *Heterosporium* in spore character. Affected leaves and branchlets are killed, turn brown, and gradually fall off, leaving shrubs thin and ragged. The lower two-thirds of the bush is affected most severely, with a tuft of healthy growth at the top. When close to a house, the side away from the wall shows most symptoms. Plants crowded in nurseries are killed in 1 to 3 years, but in home gardens they may persist for years in an unsightly condition. Conidiophores in fascicles produce conidia after girdling cankers have killed the twigs. There is often a swelling above the girdle that resembles an insect gall.

Cercospora sordida (*Mycosphaerella tecomae*) (see *Pseudocercospora sordida*) **Trumpetvine Leaf Blight** from New Jersey to Iowa and southward.

Pseudocercospora sordida (formerly *Cercospora sordida*) (*Mycosphaerella tecomae*). **Trumpetvine Leaf Blight** from New Jersey to Iowa and southward. Small, angular, sordid brown patches run together; edge of leaflets may be purplish; the fungus fruits on underside of leaves. The blight is seldom important enough to warrant control measures.

Cercosporidium

Cercosporidium punctum. **Stem and Foliage Blight** of fennel.

Choanephora

Zygomycetes, Mucorales

Mycelium profuse; sporangia and conidia present; sporangiola lacking. Sporangium pendent on recurved end of an erect, unbranched sporangiophore with a columella, containing spores provided at both ends and sometimes at the side with a cluster of fine, radiating appendages. Conidia formed in heads on a few short branches or an erect conidiophore enlarged at the tip; conidia longitudinally striate, without appendanges.

Choanephora cucurbitarum. **Blossom Blight**, **Fruit Rot**, common on summer squash and pumpkin, occasional on amaranth, cowpea, cucumber, okra, and pepper; on sweetpotato foliage, on fading hibiscus, on vinca, and other flowers. This blight is often found in home gardens in seasons of high humidity and rainfall. Flowers and young fruits are covered with a luxuriant fungus growth, first white, then brown to purple with a definite metallic luster. The fruiting bodies look like little pins stuck through this growth. Both staminate and pistillate flowers are infected, and from the latter the fungus advances into young fruits, producing a soft wet rot at the blossom end. In severe cases all flowers are blighted or fruits rotted.
Control. Grow plants on well-drained land; rotate crops. Remove infected flowers and fruits as noticed.
Choanephora infundibulifera. **Blossom Blight** on hibiscus and jasmine. **Leaf Blight** on soybean.

Ciboria

Ascomycetes, Helotiales, Sclerotiniaceae

Stroma a dark brown to black sclerotium in catkins or seed, simulating in shape the stromatized organ and not resembling a sclerotium externally. Apothecia cupulate to shallow saucer-shaped; brown.

Ciboria acerina. **Maple Inflorescence Blight** on red and silver maple. Apothecia, developed in great numbers from stromatized inflorescences on ground beneath trees, start discharging spores when maple flowers appear overhead. Mycelium spreads through stamens, calyx, and bud scales until flower cluster drops.
Ciboria carunculoides. **Popcorn Disease** of mulberry, a southern disease, not very important. Sclerotia are formed in carpels of fruit, which swells to resemble popcorn but remains green.

Ciborinia

Ascomycetes, Helotiales, Sclerotiniaceae

Stroma a thin, flat, black sclerotium of discoid type in leaves; one to several stalked apothecia arise from sclerotia; apothecia small, brown, cupulate to flat when expanded.

Ciborinia erythronii and **C. gracilis**. **Leaf Blight** of erythronium. Flat black sclerotia are prominent in leaves.

Cladosporium

► Blotch.

Cladosporium cladosporioides. **Blossom Blight** on strawberry.

Colletotrichum

► Anthracnose.

Colletotrichum acutatum. **Twig Blight** and **Fruit Spot** on dogwood.
Colletotrichum gloeosporioides. **Seedling Blight** of papaya.
Colletotrichum dematium. **Twig Blight** on vinca.

Corticium

Basidiomycetes, Aphyllophorales

Hymenium or fruiting surface of basidia consisting of a single resupinate or horizontal layer. This genus has contained a rather heterogeneous collection of species; some of the more important have been transferred to the genus *Pellicularia*.

Corticium koleroga. **Thread Blight**. ► *Pellicularia koleroga*.
Corticium microsclerotia. **Web Blight**. ► *Pellicularia filamentosa*.
Corticium salmonicolor (see *Erythricium salmonicolor*). **Limb Blight** of fig, pear, apple in Gulf States.
Corticium stevensii. **Thread Blight**. ► *Pellicularia koleroga*.
Corticium vagum, now *Pellicularia filamentosa*, teleomorph state of *Rhizoctonia solani*, causing black scurf of potatoes and damping-off and root rot of many plants. See both *Pellicularia* and *Rhizoctonia* under Rots.

Erythricium salmonicolor (formerly *Corticium salmonicolor*). **Limb Blight** of fig, pear, apple in Gulf States. The spore surface is pinkish.

Coryneum

Deuteromycetes, Coelomycetes

Acervuli subcutaneous or subcortical, black, cushion-shaped or disc-shaped; conidiophores slender, simple; spores dark with several cross walls, oblong to fusoid; parasitic or saprophytic (see Fig. 3.15).

Coryneum berckmansii (see *Seimatosporium berckmansii*). **Coryneum Blight** of Oriental arborvitae, also on Italian cypress, causing serious losses in nurseries and home gardens in the Pacific Northwest.

Coryneum microstictum (see *Seimatosperium lichehnicola*). **Twig Blight** of American bladdernut.

Coryneum carpophilum (**Cladosporium beijerinckii**) (see *Stigmina carpophila*, Anamorph, *Cladosporium beijerinckii*). **Peach Shoot Blight**, **Coryneum Blight** of stone fruits, **Shot Hole**, **Fruit Spot**, **Winter Blight**, **Pustular Spot**, general on peach in the West, also on almond, apricot, nectarine, and cherry.

Seimatosporium berckmansii (formerly *Coryneum berckmansii*). **Coryneum Blight** of Oriental arborvitae, also on Italian cypress, causing serious losses in nurseries and home gardens in the Pacific Northwest. Small twigs or branches are blighted, turn gray-green then reddish brown; many small branchlets drop, leaving a tangle of dead gray stems; larger limbs may be girdled. Twigs are dotted with black pustules bearing five-septate spores. As new growth develops in blighted areas, the spores spread the disease to young contiguous foliage. Reinfection continues until the plant is so devitalized it dies. The fungus fruits only on scale leaves or young stems.

Control. Remove and destroy blighted twigs. Apply a copper spray in September to healthy bushes as a preventive spray; apply in September and repeat in late October to infected bushes.

Seimatosporium lichenicola (formerly *Coryneum microstictum*). **Twig Blight** of American bladdernut. Young twigs are killed; the fungus winters in acervuli on this dead tissue, and spores are disseminated in spring. Prune out and burn diseased twigs during the winter.

Stigmina carpophila (formerly *Coryneum carpophilum* (*Cladosporium beijerinckii*)). **Peach Shoot Blight**, **Coryneum Blight** of stone fruits, **Shot Hole**, **Fruit Spot**, **Winter Blight**, **Pustular Spot**, general on peach in the West, also on almond, apricot, nectarine, and cherry. Twig lesions are formed on 1 -year shoots, reddish spots developing into sunken cankers; fruit buds are invaded, and there is copious gum formation. Small spots are formed on foliage, dropping out to leave typical shot holes, followed by considerable defoliation.

Apricot buds are blackened and killed during winter; fruiting wood in peaches is killed before growth starts. In late rains leaves and fruit are peppered with small, round, dead spots. Fruit lesions are raised, roughened, scabby. The fungus winters in twigs, diseased buds and spurs.

Control. In California, the standard spray for peach is bordeaux mixture applied in autumn immediately after leaf fall and before the rainy season. On apricots additional sprays are suggested for late January and at early bloom. On almonds at least two spring sprays are recommended, one at the popcorn stage of bloom, the other at petal fall.

Cryptocline

Deuteromycetes, Coelomycetes

Cryptocline cinerescens. **Twig Blight** of oaks.

Cryptospora

Scomycetes, Amphisphaeriales

Perithecia immersed in a stroma, with long necks converging into a disc; ascospores long, filiform, hyaline; conidia on a stroma.

Cryptospora longispora (see *Servazziella longispora*). **Araucaria Branch Blight**.

Servazziella longispora (formerly *Cryptospora longispora*). **Araucaria Branch Blight**. Lower branches are attacked first, with disease spreading upward; tip ends are bent and then broken off; plants several years old may be killed. Prune off and burn infected branches.

Cryptostictis

Deutermycetes, Coelomycetes

Spores dark, with several cross walls, formed in acervuli.

Cryptostictis sp. **Twig Blight** of dogwood.

Curvularia

Deuteromycetes, Hyphomycetes

Conidiophores brown, simple or sometimes branched, bearing conidia successively on new growing tips; conidia dark, three- to five-celled, with end cells lighter, more or less fusiform, typically bent or curved with central cells enlarged; parasitic or saprophytic.

Curvularia cymbopogonis. **Blight** and **Leaf Spot** of itchgrass. Leafspots coalesce after 3 or 4 days to form larger lesions and final blighting symptoms. **Curvularia lunata** (*C. trifolii* f. sp. *gladioli*). **Gladiolus Flower Blight** and **Leaf Spot**, **Curvularia Disease**. Suddenly, in 1947, a blight showed up in Florida as a serious threat to the gladiolus cut-flower industry, ruining hundreds of acres there and in Alabama in the next few months. The disease is now recorded as far north as New York and Wisconsin and on the Pacific Coast. The pathogen is usually identified as *Curvularia lunata*, known as a crop pest for many years, especially in the tropics, but studies indicate it is a special form of *C. trifolii*, cause of a leaf spot of clover.

Curvularia spots on leaf or stem are oval, tan to dark brown, showing on both sides of the leaf, bordered with a brown ring, slightly depressed and with a narrow yellowish region between the spot and normal green of the leaf. Tan centers of spots are covered with black spores resembling powder. Premature death comes when stems of young plants are girdled; florets fail to open when petioles are girdled.

Under favorable weather conditions tan spots on petals turn into a smudgy flower blight. Brown to black irregular lesions appear on corms of blooming stock and develop further in storage; the fungus survives in corms from one season to the next. This is a high temperature fungus, with optimum for growth 75° to 85°F and no infection under 55°F. A 13-hour dew period is sufficient moisture. Leaf spots show up in 4 to 5 days, spots on florets and stems in only 2 to 3 days. The complete life cycle is as short as a week in

warm rainy weather, and the fungus can survive in the soil for 3 years. Many gladiolus varieties are more or less resistant; Picardy and some others are very susceptible.

Cylindrocladium

Deuteromycetes, Hyphomycetes

Conidiophores dichotomously branched; spores hyaline, two- or several-celled.

Cylindrocladium clavatum. Blight on bird-of-paradise.
Cylindrocladium scoparium. Cylindrocladium Blight. Damping-off of seedlings and cuttings – conifers, azalea, magnolia, hydrangea, holly, pyracantha, bottle brush, and poinsettia – in greenhouses under very moist conditions. Infected azalea leaves turn black, with petiole bases softened, and drop in a few days; the bark turns brown. Leaves and stems are covered with brownish mycelial strands and white powdery masses of conidia. Control by proper humidity and aeration.
Cylindrocladium avesiculatum. Blight and Leaf Spot of *Leucothoë axillaris*.

Cylindrosporium

Deuteromycetes, Coelomycetes

Acervuli subepidermal, white or pale, discoid or spread out; conidiophores short, simple; conidia hyaline, filiform, straight or curved, one-celled or becoming septate; parasitic on leaves. Many species have *Higginsia* or *Coccomyces* as a teleomorph state.

Cylindrosporium defoliatum. Leaf Blight of Hackberry. May cause defoliation but usually unimportant.
Cylindrosporium griseum. On western soapberry.
Cylindrosporium juglandis. On walnut.

Delphinella

Ascomycetes, Dothideales

Delphinella balsameae. Tip Blight of fir.

Dendrophoma

Deuteromycetes, Coelomycetes

Pycnidia dark or light brown, superfcial or submerged and erumpent; globose or elongate, ostiolate; conidiophores elongated, branched; conidia hyaline, one-celled, elongate to ellipsoid; parasitic or saprophytic.

Dendrophoma obscurans (see *Phomopsis obscurans*). **Strawberry Leaf Blight**, **Angular Leaf Spot**. The lesions are large, circular to angular, reddish purple, zonate with age, having a dark brown center, a light brown zone, and a purple border. Spots may extend in a V-shaped area from a large vein to edge of the leaf, with black fruiting bodies appearing in the central portion. Not serious before midsummer, the disease may be destructive late in the season. The fungus winters on old leaves.
Phomopsis obscurans (formerly *Dendrophoma obscurans*). **Strawberry Leaf Blight**, **Angular Leaf Spot**.

Diaporthe

Ascomycetes, Diaporthales

Perithecia in a hard black stroma made up of host and fungal elements, first immersed, then erumpent; ascospores fusoid or ellipsoid, two-celled, hyaline. Anamorph state a *Phomopsis* with two types of spores; alpha conidia, hyaline, one-celled ovate to fusoid, and beta conidia, curved or bent stylospores.

Diaporthe arctii. **Diaporthe Blight** of Larkspur, **Stem Canker**, on annual larkspur and delphinium. Lower leaves turn brown and dry but remain attached; brown lesions at base of stems extend several inches upward and down into roots. Scattered dark pycnidia are present in stems, petioles, leaf blades, and seed capsules, the latter probably spreading the blight. Crowns are sometimes developed in a cottony weft of mycelium; perithecia develop on decaying stems. Remove and destroy diseased plants; use seed from healthy plants.
Diaporthe phaseolorum. **Lima Bean Pod Blight**, **Leaf Spot**, apparently native in New Jersey, where it was first noticed in 1891, more abundant on pole than on bush beans. Leaf spots are large, irregular, brown, often with discolored borders and large black pycnidia formed in concentric circles in dead tissue. Necrotic portions may drop out, making leaves ragged.

Pod lesions spread; pods turn black and wilted, with prominent black pycnidia. Seeds are shriveled or lacking. Spores are produced in great numbers, are disseminated by wind and pickers, and enter through stomata or wounds. The disease is most severe along the coast; optimum temperature is around 80°F. The fungus is seed-borne, but most lima bean seed is produced where the disease does not occur. Use healthy seed; clean up refuse; rotate crops.

Diaporthe phaseolorum var. **sojae**. **Soybean Pod** and **Stem Blight**, widespread. This disease was formerly confused with the more acute stem canker caused by *D. phaseolorum* var. *caulivora* (►Rots). The pod blight is a slower disease, killing plants in later stages of development. It can be identified by the numerous small black pycnidia scattered over the pods and arranged in rows on stems. The blight is more serious in wet seasons. The fungus winters on the seed and on diseased stems in the field. Use clean seed; clean up plant refuse; rotate crops.

Diaporthe phaseolorum var. **caulivora**. **Stem Blight** of soybean; also causes pod and seedling blight, stem canker, and seed decay of soybean.

Diaporthe vaccinii. **Blueberry Twig Blight**. The same fungus that causes cranberry rot blights new shoots of cultivated blueberries, entering at tips, progressing toward the base, and ultimately girdling old branches. Pycnidia develop on leaves and dead twigs. The disease is seldom serious enough for control measures.

Diaporthe vexans. **Phomopsis Blight** of Eggplant, **Fruit Rot**, general in field and market, especially in the South. Destruction is often complete, with every above-ground part affected. Seedlings rot at ground level. The first leaf spots are near the ground, definite, circular, gray to brown areas with light centers and numerous black pycnidia. The leaves turn yellow and die. Stem cankers are constrictions or light gray lesions. Fruit lesions are pale brown, sunken, marked by many black pycnidia arranged more or less concentrically. Eventually the whole fruit is involved in a soft rot or shriveling. Spores winter on seed and in contaminated soil. There is no fungicidal control. Use resistant varieties Florida Market and Florida Beauty.

Dichotomophora

►Cankers.

Dichotomophora lutea. **Stem Blight**, of common parsley.

Didymascella (Keithia)

Ascomycetes, Phacidiales, Stictidiaceae

Apothecia brown, erumpent on leaves of conifers; spores dark, two-celled, ovoid; paraphyses filiform; asci two- to four-spored.

Didymascella thujina. **Arborvitae Leaf Blight**, **Seedling Blight** of arborvitae in eastern states and of giant arborvitae, sometimes called western red cedar. The fungus is a native of North America and occurs abundantly in the West, damaging seedlings and saplings, often killing trees up to 4 years old, if they are in dense stands in humid regions. Older trees do not die, but foliage appears scorched, particularly on lower branches, and young leaf twigs may drop. Cushionlike, olive brown apothecia embedded in leaf tissue, usually upper, are exposed by rupture of the epidermis. After summer discharge of spores (round, brown, unequally two-celled) the apothecia drop out of the needles, leaving deep pits.
Control. Spray small trees and nursery stock several times during summer and fall with bordeaux mixture.
Didymascella tsugae (see *Fobrella tsugae*). **Hemlock Needle Blight**. Needles of Canada hemlock turn brown and drop in late summer. Spores are matured in apothecia on fallen needles with new infection in spring. The damage is not heavy.
Fobrella tsugae (see *Didymascella tsugae*). **Hemlock Needle Blight**. Needles of Canada hemlock turn brown and drop in late summer.

Didymella

Ascomycetes, Sphaeriales, Mycosphaerellaceae

Perithecia (or perithecia-like stromata) membranous, not carbonaceous; innate; not beaked; paraphyses present; spores two-celled, hyaline.

Didymella applanata. **Raspberry Spur Blight**, **Purple Cane Spot**, **Gray Bark**, general on raspberries, also on dewberry, blackberry. Named because it partially or completely destroys spurs or laterals on canes. The disease, known in North America since 1891, may cause losses up to 75% of the crop of individual plants of red raspberries. Dark reddish or purple spots on canes at point of attachment of leaves enlarge to surround leaf and bud and may darken lower portion of cane. Affected areas turn brown, then gray.

If buds are not killed outright during the winter, they are so weakened that the next season's spurs are weak, chlorotic, seldom blossoming. Pycnidia of the anamorph *Phoma* state and perithecia are numerous on the gray bark; ascospores are discharged during spring and early summer; on germination they can penetrate unwounded tissue.
Control. Keep plants well-spaced, allowing plenty of sunlight for quick drying of foliage and canes. Remove infected canes and old fruiting canes after harvest. A delayed dormant spray of lime sulfur or Elgetol may be advisable, followed by two sprays of ferbam or bordeaux mixture, applied when new shoots are 6 to 10 inches high and 2 weeks later.
Didymella bryoniae. Gummy stem blight and fruit spot; of watermelon.

Didymosphaeria

Ascomycetes, Dothideales

Perithecia innate or finally erumpent; not beaked; smooth; paraphyses present; spores dark, two-celled.

Didymosphaeria populina (*Venturia populina, V. tremulae, V. macularis* also cause this disease). Shoot Blight of polar, Leaf and Twig Blight. Young shoots are blackened and wilted. In moist weather dark olive green masses of spores are formed on leaves.

Diplodia

Deuteromycetes, Coelomycetes

Pycnidia innate or finally erumpent; black, single, globose, smooth; ostiole present; conidiophores slender, simple; conidia dark, two-celled, ellipsoid or ovoid. Parasitic or saprophytic.

Some species cause twig blights which are not too important: **Diplodia coluteae** on bladder senna; **D. longispora** on white oak; **Sphaeropsis sapinea** (formerly *D. pinea*) on pine; **D. sarmentorum** on pyracantha. **Lasiodiplodia theobromae** (formerly *Diplodia natalensis*) (anamorph state of *Physalospora rhodina*) causes blight, stem gumming, or stem-end rot of melons, as well as twig blight of peach and citrus. See further under Rots.
Diplodia gossypina (see *Lasiodiplodia theobromae*). Blight of slash pine and loblolly pine seedlings.

Lasiodiplodia theobromae (formerly *Diplodia gossypina*). **Blight** of slash pine and loblolly pine seedlings

Discula

Deuteromycetes, Coelomycetes

Discula quercina, **Twig Blight** of oaks.

Dothistroma

Deuteromycetes, Coelomycetes

Stroma dark, elongate, innate, becoming erumpent and swollen, with a stalk extending into the substratum, composed internally of dense, vertical hyphae; locules separate, one to several in the upper part of the stroma; conidiophores simple, slender; conidia several-celled, hyaline, long-cylindrical to filiform.

Dothistroma pini. **Needle Blight** on Austrian pine and red pine.

Cryphonectria (Endothia)

Ascomycetes, Diaporthales

Perithecia deeply embedded in a reddish to yellow stroma, with long necks opening to the surface but not beaked; paraphyses lacking; spores two-celled, hyaline. Conidia borne in hollow chambers or pycnidia in a stroma and expelled in cirrhi.

Cryphonectria parasitica. **Chestnut Blight**, **Endothia Canker**, general on chestnut. To most gardeners this disease is of only historical importance, for practically all of our native chestnuts are gone. The disease, however, persists in sprouts starting from old stumps and in the chinquapin. One of the most destructive tree diseases ever known, chestnut blight at least served to awaken people to the importance of plant disease and to the need for research in this field.

First noticed in the New York Zoological Park in 1904, the blight rapidly wiped out the chestnut stands in New England and along the Allegheny and Blue Ridge Mountains, leaving not a single undamaged tree. In 1925 the disease eliminated chestnuts in Illinois and by 1929 had reached the Pacific Northwest.

Conspicuous reddish bark cankers are formed on trunk and limbs, often swollen and splitting longitudinally. As the limbs are girdled, the foliage blights, so that brown, dried leaves are seen from a distance. The fungus fruits abundantly in crevices of broken bark, first producing conidia extruded in yellow tendrils from reddish pycnidia and later ascospores from perithecia embedded in orange stromata. Fans of buff-colored mycelium are found under affected bark.

Ascospores can be spread many miles by the wind, landing in open wounds, but the sticky conidia are carried by birds and insects. The fungus can live indefinitely as a saprophyte, and new sprouts developing from old stumps may grow for several years before they are killed.

Control. All eradication and protective measures have proved futile. Hope for the future lies in cross-breeding resistant Asiatic species with the American chestnut (and there has been some success in this line) or in substituting Chinese and Japanese chestnuts for our own.

Diplocarpon (Fabraea)

Ascomycetes, Helotiales, Dermateaceae

Apothecia develop on fallen leaves; small, disclike, leathery when dry, gelatinous when wet; asci extend above the surface of the disc; ascospores two-celled, hyaline. The anamorph stage an *Entomosporium* with distinctive cruciate four-celled conidia, each cell with an appendage, formed in acervuli (Fig. 3.9).

Didymascella tsugae (see *Fabrella tsugae*). **Hemlock Needle Blight**. Needles of Canada hemlock turn brown and drop in late summer.

Diplocarpon mespili (*Entomosporium mespili*) (formerly *Fabraea maculate*, **Entomosporium maculatum**). **Pear Leaf Blight**, **Entomosporium Leaf Spot**, **Fruit Spot**, generally distributed on pear and quince, widespread on amelanchier, sometimes found on apple, Japanese quince, medler, mountain-ash, Siberian crab, cotoneaster, loquat, photinia.

Pears may be affected as seedlings in nurseries or in bearing orchards. Very small purple spots appear on leaves, later extending to a brownish circular lesion, 1/4 inch or less in diameter, with the raised black dot of a fruiting body in the center of each spot. If spots are numerous, there is extensive defoliation. Fruit spots are red at first, then black and slightly sunken; the skin is roughened, sometimes cracked. Quince has similar symptoms.

Twig lesions appear on the current season's growth about midsummer, indefinite purple or black areas coalescing to form a canker. Primary spring infection comes more from conidia produced in these twig lesions than from ascospores shot from fallen leaves on the ground. Most commercial varieties of pear and quince are susceptible, although some are moderately resistant.

Fabraea maculate, **Entomosporium maculatum** (▸*Diplocarpon mespili*, *Entomosporium mespili*). **Pear Leaf Blight**, **Entomosporium Leaf Spot**, **Fruit Spot**, generally distributed on pear and quince, widespread on amelanchier, sometimes found on apple, Japanese quince, medler, mountain-ash, Siberian crab, cotoneaster, loquat, photinia.

Fabraea thuemenii (*Entomosporium thuemenii*). **Hawthorn Leaf Blight**, wide-spread on *Crataegus* species. Symptoms are similar to those of pear leaf blight and for a long time the pathogen was considered identical. Small dark brown or reddish brown spots, with raised black dots, are numerous over leaves, which drop prematurely in August. In wet seasons trees may be naked by late August.

Control. Because the fungus winters in twig cankers as well as in fallen leaves, sanitation has little effect. Standard recommendation has been to spray three times with bordeaux mixture, starting when leaves are half out and repeating at 2-week intervals. The copper may be somewhat phytotoxic, causing small reddish spots similar to those of blight, but it does prevent defoliation.

Fabrella tsugae (formerly *Didymascella tsugae*). **Hemlock Needle Blight**. Needles of Canada hemlock turn brown and drop in late summer. Spores are matured in apothecia on fallen needles with new infection in spring. The damage is not heavy.

Furcaspora

Deuteromycetes, Coelomycetes

Starlike botryoblastospores; acervuli become erumpent at maturity and grade into sporodochia and pycnidia.

Furcaspora pinicola. **Needle Cast** of pine.

Fusarium

► Rots.

Fusarium graminearum. **Head Blight** of wild rice.
Fusarium moniliforme var. **subglutinans**. **Blight** of slash pine and loblolly pine seedlings.
Fusarium solani. **Stem and Leaf Blight** on Spanish moss.
Fusarium subglutinans. **Foliar Blight** and **Collar Rot** on Chinese evergreen. **Seedling Blight** on pine.
Fusarium tabacinum. **Stem Blight** of squash and pumpkin.

Gibberella

Ascomycetes, Hypocreales, Nectriaceae

Perithecia superficial, blue, violet, or greenish; spores hyaline with several cells. Conidial stage in genus *Fusarium* with fusoid curved spores, several-septate. The species causing stalk rots of corn and producing gibberellic acid are more important than those causing blights.

Gibberella baccata (*Fusarium lateritium*). **Twig Blight** of ailanthus, citrus, cotoneaster, fig, hibiscus, hornbeam, peach, and other plants in warm climates, sometimes associated with other diseases.

Glomerella

► Anthracnose.

Glomerella cingulata. **Cyclamen Leaf** and **Bud Blight Leaf** and **Shoot Blight** of poplar.

Gnomonia

► Anthracnose.

Gnomonia rubi. **Cane Blight** of blackberry, dewberry, raspberry.

Hadrotrichum

Deuteromycetes, Hyphomycetes

Sporodochia cushion-shaped, dark; conidiophores dark, simple, forming a palisade and arising from a stroma-like layer; conidia dark, nearly spherical, one-celled, borne singly; parasitic on leaves.

Hadrotrichum globiferum. **Leaf Blight** of lupine.

Helminthosporium

Deuteromycetes, Hyphomycetes

Mycelium light to dark; conidiophores short or long; septate, simple or branched, often protruding from stomata of host; more or less irregular or bent, bearing conidia successively on new growing tips; conidia dark typically with more than three cells, cylindrical or ellipsoid, sometimes slightly curved or bent, ends rounded. Parasitic, often causing leaf spots or blights of cereals and grasses.

Helminthosporium catenarium (*Drechslera catenaria*). **Leaf Blight** or **Crown Rot** on creeping bentgrass; red leaf lesions and leaf tip dieback; eventually entire plant becomes blighted to crown.

Helminthosporium gigantea (*Drechslera gigantea*). **Blight** or **Zonate Leaf Spot** on wild rice and grasses.

Helminthosporium maydis (*Cochliobolus heterostrophus*). **Southern Corn Leaf Blight**, easily confused with southern corn leaf spot due to *H. carbonum*. The leaf blight occurs throughout the corn areas of the South and north to Illinois, more important on field than on sweet corn. Grayish tan to straw-colored spots with parallel sides unite to blight most of the leaf tissue. The fields appear burned by fire. Resistant varieties offer the only control.

Helminthosporium turcicum (see *Setosphaeria turcica*). **Northern Corn Leaf Blight** on field and sweet corn and on grasses; found from Wisconsin and Minnesota to Florida but more severe in states with heavy dews, abundant rainfall, and warm summers, losses running from a trace to 50%.

Setosphaeria turcica (formerly *Helminthosporium turcicum*). **Northern Corn Leaf Blight** on field and sweet corn and on grasses; found from Wisconsin and Minnesota to Florida but more severe in states with heavy dews,

abundant rainfall, and warm summers, losses running from a trace to 50%. The disease starts on the lower leaves and progresses upward. Small, elliptical, dark grayish green, water-soaked spots turn greenish tan and enlarge to spindle-shape, 1/2 to 2 inches wide, 2 to 6 inches long. Spores developing on both leaf surfaces after rain or heavy dew give a velvety dark green appearance to the center of the lesions. Whole leaves may be killed; entire fields turn dry. The fungus winters in corn residue in the field and produces spores the next spring; these are spread by wind.
Control. Use a 3-year or longer rotation.

Herpotrichia

Ascomycetes, Dothidiales

Mycelium dark, perithecia superficial; spores with several crosswalls, olivaceous when mature.

Herpotrichia juniperi. **Brown Felt Blight** of conifers at high elevations; on fir, juniper, incense cedar, spruce, pine, yew when under snow. When the snow melts, lower branches are seen covered with a dense felty growth of brown to nearly black mycelium, which kills foliage by excluding light and air as well as by invading hyphae. Small, black perithecia are scattered over the felt. This pathogen also found on dwarf mistletoe.

Heterosporium

Deuteromycetes, Hyphomycetes

Conidiophores dark, simple, bearing conidia successively on new growing tips; conidia dark, with three or more cells, cylindrical, with rough walls (echinulate to verrucose); parasitic, causing leaf spots, or saprophytic.

Heterosporium syringae. **Lilac Leaf Blight**. A velvety, olive green bloom of spores if formed in blighted, gray-brown leaf areas, which may crack and fall away. Infection is on mature leaves and the fungus is often associated with *Cladosporium*. If necessary, spray after mid-June with bordeaux mixture.

Higginisia

See *Coccomyces* under Leaf Spots.
Higginisia hiemalis. **Cherry Leaf Blight**. See *Blumeriella jaapi* and *Coccomyces biemalisi*, Cherry Leaf Spot.
Higginisia kerriae. **Kerria Leaf** and **Twig Blight**. See *Blumeriella kerriae* and Coccomyces kerriae under Leaf Spots.

Hypoderma

Ascomycetes, Rhytismatales

Ascospores formed in hysterothecia (elongated perithecia or apothecia) extending along evergreen needles; asci long-stalked; ascospores one-celled hyaline, fusiform, surrounded by a gelantinous sheath (see Fig. 3.29).

Hypoderma lethale (see *Ploidoderma lethale*). **Gray Leaf Blight** of hard pines, from New England to the Gulf States.
Ploioderma lethale (formerly *Hypoderma lethale*). **Gray Leaf Blight** of hard pines, from New England to the Gulf States. Hysterothecia are short, narrow, black; often seen on pitch pine.

Hypodermella

Ascomycetes, Rhytismatales

Like *Hypoderma* but one-celled spores are club-shaped at upper end, tapering toward base (see Fig. 3.29).

Hypodermella abietis-concoloris (see *Lirula abietis-concoloris*). **Fir Needle Blight** on firs and southern balsam.
Hypodermella laricis. **Larch Needle** and **Shoot Blight**. Yellow spots are formed on needles, which turn reddish brown but stay attached, giving a scorched appearance to trees. Hysterothecia are very small, oblong to elliptical, dull black, on upper surface of needles.
Lirula abietis-concoloris (formerly *Hypodermella abietis-concoloris*). **Fir Needle Blight** on firs and southern balsam.

Nectria (Hypomyces)

Ascomycetes, Hypocreales

Perithecia bright colored with a subicle (crustlike mycelial growth underneath); spores two-celled, light, with a short projection at one end.

Hypomyces ipomoeae (see *Nectria ipomoeae*). **Twig Blight** of bladdernut.
Nectria ipomoeae (formerly *Hypomyces ipomoeae*). **Twig Blight** of bladdernut.

Hyponectria

Ascomycetes, Hypocreales, Nectriaceae

Perithecia bright colored, soft; innate or finally erumpent; paraphyses lacking; spores one-celled, light-colored, oblong.

Hyponectria buxi. **Leaf Blight**, **Leaf Cast** of boxwood.

Itersonilia

Deuteromycetes, Hyphomycetes

Cells reproduciug by budding and germinating by repetition; clamp connections as in Basidiomycetes and probably anamorph species of *Tremellales*. The genus is not well understood.

Itersonilia perplexans. **Petal Blight** of chrysanthemum and China aster. The fungus was isolated from greenhouse chrysanthemums in Minnesota in 1951 but apparently has been present, as a parasite or saprophyte, on many other plants. On pompom chrysanthemums the tip half of outer petals turns brown and dries; the diseased tissue is filled with broad hyphae and clamp connections. Inoculated snapdragons show similar symptoms. Adequate greenhouse ventilation seems to prevent trouble. This fungus has also been reported on dill.
Itersonilia sp. **Leaf Blight**, **Canker** of parsnip, seasonal in New York and neighboring states. Plants are defoliated in cool, moist weather. Spores from leaves produce a chocolate brown dry rot on shoulder or crown of the root. Good drainage and long rotation aid in control.

Kellermannia

Deuteromycetes, Coelomycetes

Pycnidia black, globose, separate; immersed in host tissue; ostiolate; conidiophores short, simple; conidia hyaline, mostly two-celled, cylindrical with an awl-shaped appendage at the tip; parasitic or saprophytic.

Kellermania anomala (*K. yuccaegena*.) **Yucca Leaf Blight**, general on nonarborescent forms of yucca; in Florida and California on arborescent forms.
Kellermania sisyrinchii (see *Scolecosporiella sisyrinchii*.) **Leaf Blight** of blue-eyed grass.
Scolecosporiella sisyrinchii (formerly *Kellermannia sisyrinchii*.) **Leaf Blight** of blue-eyed grass.

Labrella

Deuteromycetes, Coelomycetes

Pycnidia with a radiate shield, rounded; innate or erumpent; spores hyaline, one-celled.

Labrella aspidistrae. **Leaf Blight** of aspidistra.

Leptosphaeria

Ascomycetes, Dothideales

Perithecia membranous, not beaked, opening with an ostiole; innate or finally erumpent; paraphyses present; spores dark, with several cells. Anamorph state a *Coniothryium* with black, globose pycnidia and very small, dark, one-celled conidia, extruded in a black cirrhus.

Diapleella coniothyrium (formerly *Leptosphaeria* (*Melanomma*) *conithyrium;* (*Coniothyrium fuckelii*)). **Raspberry Cane Blight**, general on raspberry, dewberry, blackberry. The same fungus causes cankers of apple and rose (►Cankers). On raspberry, brown dead areas extend into wood; whole canes or single branches wilt and die; often between blossoming and fruiting. The fungus enters the bark at any time during the season, through an insect wound or mechanical injury. Smutty patches on the bark come from

small olive conidia of the *Coniothyrium* stage and larger, dark, four-celled ascospores. Ascospores are spread by rain; conidia by rain and insects.
Control. Sanitation is very important; cut out and burn all diseased canes. A control program for spur blight should suffice for cane blight.
Leptosphaeria (Melanomma) conithyrium (**Coniothyrium fuckelii**) (see *Diapleella coniothyrium*) **Raspberry Cane Blight**, general on raspberry, dewberry, blackberry.
Leptosphaeria korrae. **Blight** on turfgrass (associated with Fusarium blight syndrome); disease is also called spring dead spot.
Leptosphaeria thomasiana. **Cane Blight** of dewberry, raspberry, in Pacific Northwest.
Leptosphaeria sp. Blight; of Miscanthus.

Linospora

►Leaf Spots.

Linospora tetraspora. **Leaf Blight** of poplar.

Lophodermella

Ascomycetes, Rhytismatales

Hymenium on a fleshy-gelatinous stroma under the bark of woody plants; ascospores aseptate.

Lophodermella sp. **Needle Cast** of pine.

Macrophomina

►Rots.

Macrophomina phaseolina. **Ashy Stem Blight**, **Charcoal Rot** of soybeans, sweetpotatoes, many other plants. ►Rots.

Micropeltis

Ascomycetes, Dothideales

A single hymenium, fruiting layer, covered with an open, reticulate scutellum; paraphyses present; spores hyaline, with several cells.

Micropeltis viburni. **Leaf Blight** of viburnum.

Monilinia (Sclerotinia)

Ascomycetes, Helotiales, Sclerotiniaceae

Stroma is a sclerotium formed in fruit by the fungus digesting fleshy tissues and replacing them with a layer of broad, thick-walled, interwoven hyphae forming a hollow sphere enclosing core or seed of fruit, which has become a dark, wrinkled, hard mummy. Apothecia funnel-form or cupulate, rarely flat-expanded, some shade of brown; asci eight-spored; ascospores one-celled, ellipsoidal, often slightly flattened on one side, hyaline. Conidia hyaline, one-celled, formed in chains in grayish masses called sporodochia.

Monilinia azaleae. **Shoot Blight** of native or pinxter azalea (*Rhododendron roseum*). Apothecia are formed on overwintered mummied fruits (capsules) in leaf mold under shrubs in moist places. Ascospores infect leaves and succulent shoots when the azalea is in full bloom. The conidial stage is common on young developing fruits in late June and July (New York).
Monilinia fructicola. **Leaf Blight** and **Shoot Blight** of peach.
Monilinia johnsonii. **Leaf Blight**, **Fruit Rot** of hawthorn.
Monilinia laxa. **Blossom Blight**, **Brown Rot** of apricot, almond, cherry, plum, and prune on Pacific Coast. Blossoms and twigs are blighted with a good deal of gum formation. *Monilinia laxa* is sometimes coincident with, and confused with, *M. fructicola*, which causes a more general rot of stone fruits. Both are discussed more fully under Rots.
Monilinia rhododendri (*Sclerotinia seaveri*). **Twig Blight**, **Seedling Blight** of sweet cherry.

Mycosphaerella

► Anthracnose.

Mycosphaerella citrullina (*M. melonis*) conidial stage *Didymella bryoniae*. **Gummy Stem Blight**, **Stem End Rot**, **Leaf Spot** of watermelon,

muskmelon, summer squash, pumpkin, and cucumber. Gray to brown dead areas in leaves are marked with black pycnidia; leaves may turn yellow and shrivel. Stem infection starts with a water-soaked oily green area at nodes. The stem is girdled, covered with a dark exuded gum, and the vine wilts back to that point. Fruit rot starts gray, darkens to nearly jet black, with gummy exudate.

Control. Clean up crop refuse; practice rotation. Some varieties are more resistant than others.

Mycosphaerella fijiensis. **Black Sigatoka** on dwarf banana in FL.

Mycosphaerella melonis. **Gummy Stem Blight** of cucumbers.

Mycosphaerella pinodes. **Pea Blight**. ▸*Ascochyta pinodes*.

Mycosphaerella rabiei (Anamorph, *Phoma rabiei*). **Blight** of chickpea

Mycosphaerella sequoiae. **Needle Blight** of redwood.

Myriogenospora

Ascomycetes, Hypocreales

Ascomata superficial or in a stroma, fleshy, bright-colored; ascus with a thick cap traversed by a slender pore; ascospores filifrom, multiseptate, often fragmenting.

Myriogenospora atramentosa. **Blight** on turf grass, centipedegrass.

Mystrosporium

Deuteromycetes, Hyphomycetes

Conidia dark, muriform; hyphae long.

Bipolaris iridis (formerly *Mystrosporium adustum*). **Leaf Blight**, **Ink Spot** of bulbous iris; also on montbretia and lachenalia. Irregular black patches or blotches appear soon after leaves push through the ground; under moist conditions the foliage withers and dies prematurely. Inky black stains appear on husks of bulbs (usually *Iris reticulata*), and yellow dots or elongated sunken black craters show on fleshy scales. The bulbs may rot,leaving only the husk and a mass of black powder. The fungus spreads through the soil, invading adjacent healthy bulbs.

Control. Dig bulbs every year; discard all diseased bulbs and debris; plant in a new location. Spray with bordeaux mixture.

Mystrosporium adustum (see *Bipolaris iridis*). **Leaf Blight**, **Ink Spot** of bulbous iris; also on montbretia and lachenalia.

Myxosporium

Deuteromycetes, Coelomycetes

Conidia hyaline, one-celled, in discoid to pulvinate acervuli on branches.

Myxosporium diedickei. **Twig Blight** of mulberry.
Myxosporium everhartii. **Twig Blight** of dogwood. **M. nitidum**. Twig blight and dieback of native dogwood. Prune twigs back to sound wood; feed and water trees.

Neopeckia

Ascomycetes, Dothideales

Perithecia hairy, not beaked, formed on a mycelial mass; paraphyses present; spores two-celled, dark.

Neopeckia coulteri. **Brown Felt Blight** on pines only, otherwise similar to brown felt blight caused by *Herpotrichia*, a disease of high altitudes on foliage under snow.

Ovulinia

Ascomycetes, Helotiales, Sclerotiniaceae

Stroma a sclerotium, thin, circular to oval, shallowly cupulate, formed in petal tissue but falling away; minute globose spermatia; apothecia of *Sclerotinia* type, small; asci eight-spored; paraphyses septate with swollen tips; conidia large, obovoid, one-celled except for basal appendage or disjunctor cell; borne singly at tips of short branches of mycelium forming a mat over surface of petal tissue (see Fig. 3.9).

Ovulinia azaleae. **Azalea Flower Spot**, **Petal Blight**, very destructive to southern azaleas in humid coastal regions, occasional on mountain-laurel and rhododendron. Starting as a sudden outbreak near Charleston, South Carolina, 1931, the disease spread rapidly north of Wilmington, North Carolina, down the coast to Florida, and around the Gulf. It reached Texas by 1938 and

was in California by 1940; it was reported in Maryland in 1945, in Virginia in 1947, and in Philadelphia in 1959. Petal blight was reported from a Long Island, New York, greenhouse in 1956, apparently present there since 1952, and in 1959 infected all the azaleas in one New Jersey greenhouse. In both cases the blight started on plants purchased from the South. This is the most spectacular disease that I have ever witnessed, with most of the bloom on all the azaleas in a town blighting simultaneously and seemingly overnight under special weather conditions. The blight does not injure stem or foliage; it is confined to the flowers. The loss is aesthetic and economic from the standpoint of tourist trade. For many years, before a control program was worked out, the great azalea gardens of the South had to close their gates to visitors far too early in the season.

Primary infection comes from very small apothecia produced from sclerotia on the ground under shrubs, usually in January or February, occasionally as early as December. Spores shot into the air are carried by wind drift to flowers near the ground of early varieties, initial spots being whitish. If you put your finger on such a spot, the tissue melts away. With continued high humidity, heavy fog, dew, or rain, conidia are produced over the inner surfaces of petals and are widely disseminated to other petals by wind, insects, and splashed rain. Within a few hours colored petals are peppered with small white spots, and white flowers have numerous brown spots. By the next day flowers have collapsed into a slimy mush, bushes looking as if they had had scalding water poured over them. If the weather stays wet, small black sclerotia are formed in the petals in another 2 or 3 days. Infected blooms seldom drop normally but remain hanging on the bushes in an unsightly condition for weeks and months, some even to the next season. Many of the sclerotia, however, drop out and remain in the litter on the ground ready to send up apothecia the next winter.

Both Indian and Kurume varieties are attacked, the peak of infection coming with mid-season varieties such as Pride of Mobile or Formosa. In some seasons dry weather during early spring allows a good showing of azaleas; in other years blight starts early and there is little color unless azaleas are sprayed. On Belgian azaleas in greenhouses blight may start in December.

Control. Some mulches and soil treatments will inhibit apothecial production. Secondary infection is bound to come from some untreated azalea in the neighborhood. Spraying gives very effective, even spectacular, control if started on time, when early varieties are in bloom and midseason azaleas are showing color. Sprays must be repeated three times a week as long as

petal surface is expanding, about 3 or 4 weeks. After that, weekly spraying is sufficient. Spraying is mandatory now for the big azalea gardens, and the admission fees from the lengthened season pay for the program many times over.

The original successful formula was: Dithane D-14 (nabam) 1 1/3 quarts to 100 gallons water, plus 1 pound 25% zinc sulfate, 1/2 pound hydrated lime, and 1 ounce of spreader Triton B 1956. Later work showed that the lime could be omitted, Dithane reduced to 1 quart, and zinc sulfate to 2/3 pound to prevent injury in periods of drought. The spray should be a fine mist, applied from several directions to get adequate coverage.

Commercial growers should beware of ordering azaleas from the South unless they are bare-rooted and all flower buds showing color removed. As a matter of fact, any potted or balled and burlapped plant grown in a nursery near azaleas could very easily bring along some of the tiny sclerotia in the soil, and they might remain viable more than 1 year. All traces of soil should be washed off roots, and the plants wrapped in polyethylene for shipping.

Pellicularia

Basidiomycetes, Aphyllophorales

Includes some species formerly assigned to *Corticium, Hypochnus*, and *Peniophora*. Hyphae stout, very short-celled; mycelium branching at right angles; basidia very stout, formed on a resupinate, cottony or membranous layer of mycelium. Anamorph state a *Rhizoctonia*, with sclerotia made up of brown, thin-walled, rather angular cells, or *Sclerotium*, with sclerotia having a definite brown rind and light interior.

Athelia rolfsii (formerly *Pellicularia rolfsii* (Anamorph, *Sclerotium rolfsii*). **Southern Blight**, **Crown Rot**. The disease has been known, in its sclerotium stage, for many years on hundreds of plants. The connection with *Pellicularia* is recent, and the name does not have universal agreement. One strain of the fungus has been called *Sclerotium delphinii* in the North, where the disease is usually designated crown rot. This is, however, a variable fungus with single spore cultures from the *Pellicularia* stage producing sclerotia typical of *Sclerotium delphinii* and of *S. rolfsii*, with intermediate forms. Sclerotia of the southern blight strain are very small, round, tan, about the size, shape, and color of mustard seed, the pathogen being frequently called the mustard-seed fungus.

Southern blight affects almost all plants except field crops like wheat, oats, corn, and sorghum. Fruits and vegetables include Jerusalem artichoke, avocado, bean, beet, carrot, cabbage, cucumber, eggplant, endive, lettuce, melon, okra, onion, garlic and shallot, pea, peanut, pepper, potato, rhubarb, strawberry, sweetpotato, tomato, turnip, and watermelon. Ornamentals, too numerous to list in entirety, include ajuga, ageratum, amaryllis, azalea, caladium, calendula, campanula, canna, carnation, cosmos, China aster, chrysanthemum, dahlia, delphinium, daphne, duranta, gladiolus, hollyhock, hydrangea, iris, jasmine, lemon verbena, lily, lupine, marigold, morning-glory, myrtle, narcissus, orchids, phlox, pittosporum, rose, rose-mallow, rudbeckia, scabiosa, sedum, sweet pea, star-of-bethlehem, tulip, violet, and zinnia.

The first sign of blight is the formation of white wefts of mycelium at the base of the stem, spreading up in somewhat fan-shaped fashion and sometimes spreading out over the ground in wet weather. The sclerotia formed in the wefts are first white, later reddish tan or light brown. They may be numerous enough to form a crust over the soil for several inches around a stem, or they may be somewhat sparse and scattered.

In the white stage, droplets of liquid often form on the sclerotia, and the oxalic acid in this liquid is assumed to kill plant cells in advance of the fungus hyphae. This means that the pathogen never has to penetrate living tissue and explains why so many different kinds of plants succumb so readily to southern blight. Fruits touching the ground, as well as vegetables with fleshy roots, like carrots and beets, or plants with bulbs or rhizomes, like onions, narcissus, and iris, seem particularly subject to this disease. Low ornamentals such as ajuga blight quickly, the whole plant turning black; tall plants like delphinium rot at the crown and then die back or topple over; bulbs have a cheesy interior, with sclerotia forming on or between the scales.

Control. Remove diseased plants as soon as they are noticed. Take out surrounding soil, for 6 inches beyond the diseased area, wrapping it carefully so that none of the sclerotia drop back. Increasing the organic content of the soil reduces southern blight, as does the addition of nitrogenous fertilizers, such as ammonium nitrate. Treating narcissus bulbs in hot water for 3 hours, as for nematodes, kills the fungus in all except the very largest bulbs.

Pellicularia filamentosa (see *Thanatephorus cucumeris*), teleomorph state of *Rhizoctonia solani*. This is a variable fungus with some strains or forms causing leaf blights but best known as cause of Rhizoctonia rot of potatoes and damping-off of many plants. ►Rots.

Pellicularia filamentosa f. sp. **microsclerotia** (*Corticium microsclerotia*) see *Thanatephorus cucumeris*. **Web Blight** of snap bean, lima bean, also reported on fig, elder, hibiscus, hollyhock, tung oil, and phoenix tree, from Florida to Texas. Many small brown sclerotia and abundant weblike mycelium are found on bean stems, pods, and foliage. Infection starts with small circular spots that appear water-soaked or scalded. They enlarge to an inch or more, become tan with a darker border, are sometimes zonate. The whitish mycelium grows rapidly over the leaf blade, killing it, and spreads a web from leaf to leaf, over petioles, flowers, and fruit, in wet weather and at temperatures 70° to 90°F; in dry weather growth is inconspicuous except on fallen leaves. The fungus is spread by wind, rain, irrigation water, cultivating tools, and bean pickers; it survives in sclerotial form from season to season. *Control*. Destroy infected plants; clean up refuse. In Florida, do not plant beans between June and September if web blight has been present. Use a copper spray or dust.

Pellicularia filamentosa f. sp. **sasakii**. See *Thanatephonus cucumeris*. **Leaf Blight** of grasses, clover, etc.

Pellicularia filamentosa f. sp. **timsii**. See *Thanatephonus cucumeris*. **Leaf Blight** of fig.

Pellicularia rolfsii. See *Athelia rolfsii*, Anamorph, ►*Sclerotium rolfsii*. **Southern Blight**, **Crown Rot**. The disease has been known, in its sclerotium stage, for many years on hundreds of plants. The connection with *Pellicularia* is recent, and the name does not have universal agreement. One strain of the fungus has been called *Sclerotium delphinii* in the North, where the disease is usually designated crown rot. This is, however, a variable fungus with single spore cultures from the *Pellicularia* stage producing sclerotia typical of *Sclerotium delphinii* and of *S. rolfsii*, with intermediate forms. Sclerotia of the southern blight strain are very small, round, tan, about the size, shape, and color of mustard seed, the pathogen being frequently called the mustard-seed fungus.

Southern blight affects almost all plants except field crops like wheat, oats, corn, and sorghum. Fruits and vegetables include Jerusalem artichoke, avocado, bean, beet, carrot, cabbage, cucumber, eggplant, endive, lettuce, melon, okra, onion, garlic and shallot, pea, peanut, pepper, potato, rhubarb, strawberry, sweetpotato, tomato, turnip, and watermelon. Ornamentals, too numerous to list in entirety, include ajuga, ageratum, amaryllis, azalea, caladium, calendula, campanula, canna, carnation, cosmos, China aster, chrysanthemum, dahlia, delphinium, daphne, duranta, gladiolus, hollyhock,

hydrangea, iris, jasmine, lemon verbena, lily, lupine, marigold, morning-glory, myrtle, narcissus, orchids, phlox, pittosporum, rose, rose-mallow, rudbeckia, scabiosa, sedum, sweet pea, star-of-bethlehem, tulip, violet, and zinnia.

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Pellicularia koleroga (*Corticium stevensii*). Thread Blight, a southern disease, from North Carolina to Texas, important on fig and tung, sometimes defoliating pittosporum, crape myrtle, roses, and other ornamentals, and some fruits. The disease is recorded on apple, azalea, banana shrub, blackberry, boxwood, camphor, cherry laurel, chinaberry, columbine, crabapple, crape myrtle, casuarina, currant, dewberry, dogwood, elderberry, elm, erythrina, euonymus, fig, flowering almond, flowering quince, goldenrod, gooseberry, guava, honeysuckle, hibiscus, morning glory, pear, pecan, pepper vine, persimmon, pittosporum, plum, pomegranate, quince, rose, satsuma orange, soapberry, silver maple, sweetpotato, tievine (*Jacquemontia*), tung, Virginia creeper, and viburnum.

The fungus winters as sclerotia on twigs and leaf petioles, and in May and June produces threadlike mycelium that grows over lower surface of leaves, killing them and causing premature defoliation, although often dead leaves hang on the tree in groups, matted together by thread-like spider webs. Fruiting patches on leaves are first white, then buff. The fungus flourishes in moist weather, temperatures 75° to 90°F.

Control. On figs, one or two applications of tribasic copper sulfate, or bordeaux mixture, are satisfactory until the fruit ripens in July. Pruning out infected branches may be sufficient on tung and pecan, but at least one spray of bordeaux mixture may be required.

Thanatephonus cucumeris (formerly *Pellicularia filamentosa*), teleomorph state of *Rhizoctonia solani*. This is a variable fungus with some strains or forms causing leaf blights but best known as cause of Rhizoctonia rot of potatoes and damping-off of many plants. ►Rots.

Thanatephonus cucumeris (formerly *Pellicularia filamentosa* f. sp. *microsclerotia* (*Corticium microsclerotia*)). **Web Blight** of snap bean, lima bean, also reported on fig, elder, hibiscus, hollyhock, tung oil, and phoenix tree, from Florida to Texas. Many small brown sclerotia and abundant weblike mycelium are found on bean stems, pods, and foliage. Infection starts with small circular spots that appear water-soaked or scalded. They enlarge to an inch or more, become tan with a darker border, are sometimes zonate. The whitish mycelium grows rapidly over the leaf blade, killing it, and spreads a web from leaf to leaf, over petioles, flowers, and fruit, in wet weather and at temperatures 70° to 90°F; in dry weather growth is inconspicuous except on fallen leaves. The fungus is spread by wind, rain, irrigation water, cultivating tools, and bean pickers; it survives in sclerotial form from season to season.

Control. Destroy infected plants; clean up refuse. In Florida, do not plant beans between June and September if web blight has been present. Use a copper spray or dust.

Thanatephonus cucumeris (formerly *Pellicularia filamentosa* f. sp. *sasakii*). **Leaf Blight** of grasses, clover, etc.

Thanatephorus cucumeris (formerly *Pellicularia filamentosa* f. sp. *timsii*). **Leaf Blight** of fig.

Penicillium

► Cankers.

Penicillium oxalicum. **Leaf Blight** of grass.

Pestalotia

Deuteromycetes, Coelomycetes

Acervuli dark, discoid or cushion-shaped, subcutaneous; conidiophores short, simple; conidia fusiform, several-celled with median cells colored, end cells hyaline, a short stalk at the basal cells and a crest of two or more hyaline appendages, setae, from the apical cell (Fig. 3.9). Weak parasites or saprophytes; some are treated under Leaf Spots.

Pestalotia funerea (see *Pestalotiopsis funerea*). **Tip Blight** of conifers, **Needle Blight**, **Twig Blight** of chamaecyparis, retinospora, cypress, bald cypress, arborvitae, juniper, yew, and giant sequoia.
Pestalotia hartigii. Associated with a basal stem girdle of young conifers but parasitism not proven. The stem has a swelling above the girdling lesions, and the tree gradually turns yellow and dies. The effect may be more from high temperature than the fungus; shading transplants is helpful.
Pestalotia sp. and **Penicillium** sp. **Flower Blight** on camellia.
Pestalotiopsis funerea (formerly *Pestalotia funerea*). **Tip Blight** of conifers, **Needle Blight**, **Twig Blight** of chamaecyparis, retinospora, cypress, bald cypress, arborvitae, juniper, yew, and giant sequoia. The fungus is saprophytic on dead and dying tissue and also weakly parasitic, infecting living tissue through wounds under moist conditions. It appears in sooty pustules on leaves, bark, and cones.

Phacidium

Ascomycetes, Helotiales

Apothecia innate, concrete above with the epidermis and slitting with it into lobes; spores one-celled, hyaline.

Phacidium abietinellum (see *Nothophacidium abietinellum*). **Needle Blight** of balsam fir.

Phacidium balsameae (see *Sarcotrochilia balsameae*). **Needle Blight** of balsam fir in New England, of white and alpine fir in the Northwest.
Phacidium infestans. **Snow Blight** of conifer seedlings on fir and young pines in the Northeast, also on arborvitae and spruce; on white and alpine fir in the Northwest. This native fungus is most damaging in nurseries, attacking foliage under the snow. The needles turn brown, with a covering of white mycelium, just as the snow melts. In late summer and fall brown to nearly black apothecia appear on underside of browned needles. Ascospores are spread by wind, primary infection being in autumn. Additional infection occurs in late winter, when mycelium grows out under the snow from diseased to dormant, healthy needles.
Control. Spray nursery beds with dormant-strength lime sulfur in late fall; remove infected seedlings; dip new stock in lime sulfur before planting.
Nothophacidium abietinellum (formerly *Phacidium abietinellum*). **Needle Blight** of balsam fir.
Sarcotrochilia balsameae (formerly *Phacidium balsameae*). **Needle Blight** of balsam fir in New England, of white and alpine fir in the Northwest.

Phaeoacremonium

Phaeoacremonium chlamydosporum. **Black Goo** on grape.

Phialophora

► Rots.

Phialophora graminicola. **Blight** on turfgrasses (associated with Fusarium blight syndrome).

Phloeospora

Deuteromycetes, Coelomycetes

Pycnidia dark,imperfectly formed, globose, innate in tissue, not in distinct spots; conidia hyaline or subhyaline, several-celled, elongate fusoid to filiform; parasitic or saprophytic. One of the conidial forms linked with *Mycosphaerella* as a teleomorph state.

Phloeospora adusta. **Leaf Blight** of clematis.

Phoma

► Blackleg.

Phoma conidiogena (see *Phoma glomerata*). **Boxwood Tip Blight**. Ashy gray necrotic areas at leaf tips, with pycnidia on both leaf surfaces.
Phoma glomerata (formerly *Phoma conidiogena*). **Boxwood Tip Blight**. Ashy gray necrotic areas at leaf tips, with pycnidia on both leaf surfaces.
Phoma fumosa. **Twig Blight**, occasional on maple.
Phoma macdonaldii. **Blight**, **Premature Ripening** of sunflower.
Phoma mariae. **Twig Blight** on Japanese honeysuckle.
Phoma piceina. **Twig and Needle Blight** of Norway spruce. May cause defoliation and sometimes death of forest trees.
Phoma sclerotioides. **Brown Root Rot** of alfalfa.
Phoma strobiligena (see *Sclerophoma pythiophila*), on cone scales of Norway spruce.
Sclerophoma pythiophila (formerly *Phoma strobiligena*), on cone scales of Norway spruce.

Phomopsis

Deuteromycetes, Coelomycetes

Pycnidia dark, ostiolate, immersed, erumpent, nearly globose; conidiophores simple; conidia hyaline, one-celled, of two types-ovate or ellipsoidal and long, filamentous, sickle-shaped or hooked at upper end (Fig. 3.9). Anamorph state of *Diaporthe*; parasitic causing spots on various plant parts.

Dendrophoma obscurans (see *Phomopsis obscurans*). **Strawberry Leaf Blight**, **Angular Leaf Spot**.
Phomopsis ambigua (teleomorph, *Diaporthe eres*). **Twig Blight** of pear, widespread.
Phomopsis diospyri. **Twig Blight** of native persimmon.
Phomopsis japonica. **Twig Blight** of kerria.
Phomopsis juniperovora. **Nursery Blight**, **Juniper Blight**, **Cedar Blight**, **Canker** on red-cedar and other junipers, cypress, chamaecyparis, Japanese yew (*Cephalotaxus*), arborvitae, giant sequoia, and redwood. This disease occurs in virulent form from New England to Florida and through the Middle West; it may also occur on the Pacific Coast.

Tips of branches turn brown with progressive dying back until a whole branch or even a young tree is killed. Trees over 5 years old are less seriously injured. Spores produced in quantity in pycnidia on diseased twigs ooze out in little tendrils in moist weather, to be spread by splashing water, insects, and workers. Entrance is through unbroken tissue as well as wounds; the stem is killed above and below the point of entrance. Small, sunken lesions give a flattened appearance to some seedlings. Overhead irrigation in a nursery is a predisposing factor, and a large amount of stock can be blighted in a very short time. Older trees in home plantings suffer from twig blight. The fungus winters on infected plant parts and remains viable at least 2 years.
Control. Have seedbeds well drained; water by ditch irrigation; remove and burn diseased seedlings early in the season; keep seedbeds away from older cedar trees; do not use cedar branches or needles for mulching. Spray with fixed copper or bordeaux mixture plus a wetting agent, starting when growth begins and repeating to keep new foliage covered. Spiny Greek and Hill junipers and Keteller red-cedars are somewhat resistant.
Phomopsis kalmiae. **Mountain-Laurel Leaf Blight**, **Blotch**. Circular, brown, often zonate areas on leaves, frequently starting near margin or tip, gradually enlarge and coalesce until most of the blade is involved. The fungus often works down the petiole to cause a twig blight. The disease is more prominent on bushes in the shade or under drip of trees. Remove blighted leaves or clean up fallen leaves.
Phomopsis longicolla. **Black Pod Spot** and **Seed** on cowpea.
Phomopsis oblonga. **Twig Blight** on Chinese elm.
Phomopsis obscurans (formerly *Dendrophoma obscurans*). **Strawberry Leaf Blight**, **Angular Leaf Spot**. The lesions are large, circular to angular, reddish purple, zonate with age, having a dark brown center, a light brown zone, and a purple border. Spots may extend in a V-shaped area from a large vein to edge of the leaf, with black fruiting bodies appearing in the central portion. Not serious before midsummer, the disease may be destructive late in the season. The fungus winters on old leaves.
Phomopsis occulta. **Shoot Blight** of Colorado blue spruce.
Phomopsis vexans. **Phomopsis Blight** of eggplant. ► *Diaporthe vexans*.
Phomopsis vaccinii. **Twig Blight** of blueberry.

Phyllosticta

Deuteromycetes, Coelomycetes

Pycnidia dark, with ostiole, in spots in leaves; spores one-celled, hyaline. The characteristics are the same as *Phoma* except that leaves rather than stems are infected. Other species are listed under Leaf Spots.

Phyllosticta batatas. **Sweet Potato Leaf Blight**, occasional from New Jersey to Florida, more prevalent in the South but seldom important enough for control measures. Numerous white spots on leaves are bordered with narrow reddish zones; pycnidia are numerous; spores are extruded in tendrils.
Phyllosticta cryptomeriae. **Needle Blight** found on *Cryptomeria*.
Phyllosticta lagerstroemiae. **Tip Blight** of crape-myrtle.
Phyllosticta multicorniculata. **Needle Blight** of fir.
Phyllosticta pteridis. **Tip Blight** of fern. Leaves lose green color; spots are ash gray with purple brown margins and numerous black pycnidia in center. A very weak bordeaux mixture has been suggested for control; if overhead watering is avoided, spraying may not be necessary.

Physalospora

Ascomycetes, Sphaeriales

Perithecia with papillate mouths, immerse in substratum but without well-defined stromata; paraphyses present; spores one-celled, hyaline. A few species cause blights; many cause rots.

Botryosphaeria obtusa (formerly *Physalospora obtusa*). **Cane Blight** of rose, also **Black Rot** of apple, **Canker** and **Dieback** of many plants. ►Cankers and also ►Rots.
Glomerella cingulata (formerly *Physalospora dracaenae*). **Dracaena Tip Blight**, **Leaf Spot**. Disease starts at the tips of lower leaves and spreads down toward the base. Infected areas are sunken and straw-colored, dotted with black specks of pycnidia. All leaves on the plant may die except a few at the top. Remove infected leaves as soon as noticed. Spray with a copper fungicide.
Physalospora dracaenae (►*Glomerella cingulata*). **Dracaena Tip Blight**, **Leaf Spot**.
Physalospora gregaria. **Twig Blight** of yew.

Physalospora obtusa (see *Botryosphaeria obtusa*). **Cane Blight** of rose, also **Black Rot** of apple, **Canker** and **Dieback** of many plants.

Phytophthora

Oomycetes, Peronosporales

This most important genus contains many species causing destructive blights, cankers, and rots. The name, which means "plant destroyer," was given in 1876 for the potato blight fungus. Sporangia, formed successively on sporangiophores, slender, sparsely branched hyphae emerging from stomata, germinate either by a germ tube or by zoospores. The sexual spore is an oospore.

Phytophthora cactorum. **Lilac Shoot Blight**. Blossoms and succulent growing tips are blighted and turn brown; suckers are killed back 4 or 5 feet. Blight is most severe in wet springs when shrubs are crowded, shaded, and improperly pruned. The same fungus causes a canker, foot rot, and dieback of rhododendron and other plants and is considered again under Cankers. Avoid planting lilacs and rhododendrons close together. Prune each year for air circulation and to remove dead twigs.

Phytophthora capsici. **Phytophthora Blight** of Pepper, **Leaf and Stem Blight** of Squash, Fruit Rot of pepper, eggplant, tomato, cucumber, and melon. The disease was first found in New Mexico in 1918 injuring chili peppers; it occurs chiefly in southwestern and Gulf states. In 1953, however, it was reported that for some years it had been causing a leaf blight of squash in North Carolina.

Pepper plants are girdled at the soil line with a dark green water-soaked band, which dries and turns brown, followed by wilting and death of the entire plant. Leaf spots are dark green and small at first, later large bleached or scalded areas. Dark, watersoaked patches on fruits are covered with white mycelium. The fruit withers but remains attached; 60% of green fruit may be infected in southwestern commercial plantings. Seed are infected from the fruit. Symptoms on squash are somewhat similar; green leaf lesions spreading over the blade, a basal stem rot, and wilting. Wet soil and high temperatures encourage blight.

Control. Place seedbeds on land that has not previously grown peppers; rotate crops. Avoid over irrigation.

Phytophthora citrophthora (also *P. citricola* and *P. nicotianae* var. *parasitica*). **Shoot and Stem Blight** on azalea. **Needle Blight** and **Branch Dieback** of sequoia.

Phytophthora erythroseptica. **Leaf Blight** of pink and golden calla. Leaves are wilted and distorted; petioles are black and soft.

Phytophthora ilicis. **Holly Blight**, **Phytophthora Leaf** and **Twig Blight**, the most serious disease of English holly, particularly serious in the Northwest. For many years the trouble was ascribed to *Boydia insculpta* and called Boydia canker, but this fungus merely invades tissue killed by *Phytophthora*. Leaf spots are dark, developing on lower leaves in cool rainy weather and progressing upward in late fall and winter. Young twigs die back; black stem cankers kill older twigs. Young plants in nurseries are defoliated and sometimes killed.

Control. Choose a planting site with moderate air movement; space trees well apart. Prune out all cankered and blighted twigs; prune also for air movement through trees. Spray with tribasic copper sulfate, starting the middle of October.

Phytophthora infestans. **Late Blight** of potato and tomato, general on potato in the Northeast, in Middle Atlantic and North Central states, sometimes in Gulf and western states; on tomato in humid regions and seasons.

Here is a pathogen that has not lost its destructive virulence with passage of time. In 1946, a whole century after potato blight caused the famous Irish famine, tomato blight devastated tomatoes along the eastern seaboard, both in home gardens and canning fields.

The potato went to Europe from South America shortly before 1600, seemingly leaving its pathogens at home. For 200 years potatoes thrived in Europe as the main source of carbohydrate food, but in August 1845, the *Gardener's Chronicle* reported: "A fatal malady has broken out amongst the potato crop. On all sides we hear of destruction. In Belgium the fields are said to have been completely desolated. There is hardly a sound sample in Covent Garden Market." The editor went on to describe the decay and to say: "As to cure for this distemper there is none. One of our correspondents is today angry with us for not telling the public how to stop it; but he ought to consider that Man has no power to arrest the dispensations of Providence. We are visited by a great calamity which we must bear." And in 1946 American gardeners were again blaming the editor, for lack of information on tomato blight.

In 1845 the weather was continued gloom and fog, with below-average temperatures. The *Gardener's Chronicle* editor was sure blight was due to potatoes being overladen with water. The Rev. M. J. Berkeley disagreed. He insisted blight was due to a fungus, with the weather contributing to spread

of a moisture-loving parasite. The argument raged, for this was long before Pasteur and his germ theory, and the first time anyone believed a fungus could be the cause and not the consequence of plant disease. A French scientist, Montagne, named the fungus *Botrytis infestans*, but the first really good description of it was published by Berkeley, and it remained for the German de Bary, in 1876, actually to prove the pathogenic nature of the fungus and to erect the new genus *Phytophthora* to include it.

Meanwhile the disease was making history. The loss of the potato crop in 1845 and 1846 killed off a million people and caused another million and a half to emigrate; the first Government Relief program was instigated; and the English Corn Laws were repealed with a change to a policy of free trade and unbounded expansion of commerce.

Late Blight of Potato

Symptoms. After blossoming, large, dark green, water-soaked spots appear on leaves in wet weather, first on lower leaves. As a spot enlarges the center is shriveled, dry, dark brown to black, and a downy, whitish growth appears on the underside of leaves. Similar lesions are formed on stems and petioles, and there is a characteristic strong odor as tops are blighted. On tubers, first symptoms are small brown to purple discolorations of skin on upper side, changing to depressed pits when tubers are removed from soil and put in storage (see Fig. 3.12). On cutting through the potato, a reddish brown dry rot is seen.

Life History. The primary cycle starts with infected tubers, which have harbored mycelium in the dry rot patches over winter. If infected seed pieces are planted, the fungus grows systemically into the shoots and finally fruits by sending sporangiophores out through the stomata on lower leaf surfaces (see Fig. 3.13). These swell at the tips into ovoid bodies, sporangia, then branch and produce successively more sporangia. The latter may function as conidia, putting out a germ tube, but more often are differentiated into a number of swarmspores (zoospores), which have cilia enabling them to swim about after they are splashed by rain to another leaf. Eventually they stop swimming and send a germ tube in through the leaf cuticle or enter through a stoma. Initial infection in the field also comes from conidia blown over from sprouts produced on infected tubers in cull piles. Blighting follows rapidly, with first symptoms 5 days or less from the time of infection

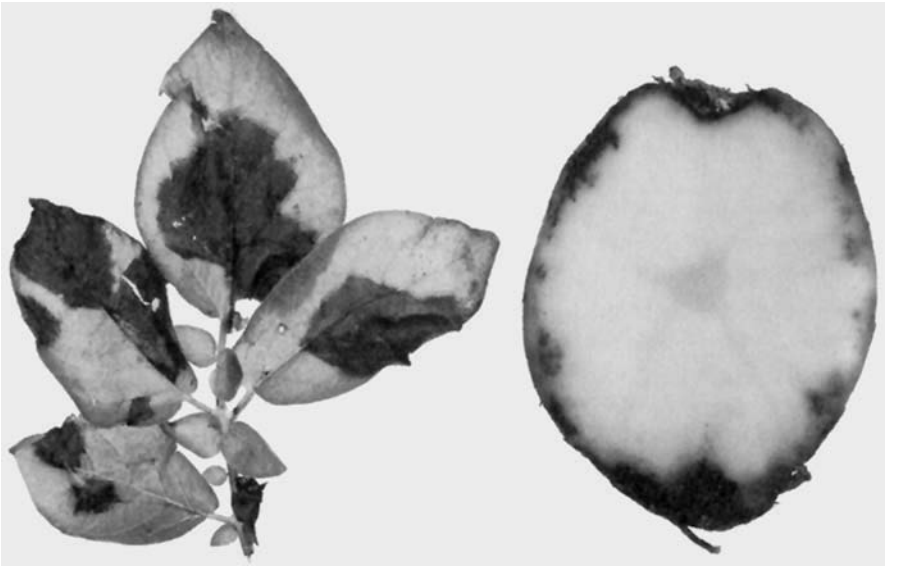

Figure 3.12 Late Blight on Potato

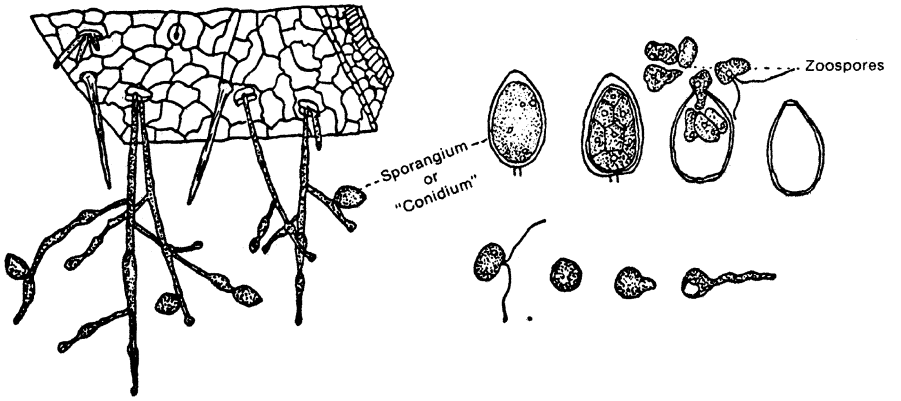

Figure 3.13 Late Blight of Potatoes. Sporangiophores of *Phytophthora infestans* emerging from leaf, bearing sporangia, sometimes called conidia, which germinate by zoospores

and with the fungus fruiting again in a whitish layer on the underside of leaves.

Tubers with only a thin covering of soil may be infected by swarmspores washing down onto them from blighted leaves overhead; they are also infected during digging if it is done in moist weather while tops are still green.

Swarmspores remain viable in the soil several weeks while awaiting favorable conditions. Oospores, the sexual spores, are apparently not required in the life cycle for they are not found with potatoes grown in the field. They have been produced in culture.

Weather Relations. This is a disease entirely dependent on weather conditions. Temperature and moisture conditions are right for an epiphytotic about 2 years out of 5. Zoospores are produced only in cool weather, 60°F and under, but they invade leaves most rapidly at higher temperatures. Because they are swimming spores, rain is required. A cool, wet July is usually followed by blight in August and September.

Control. Some varieties, such as Kennebec, Essex, Pungo, and Cherokee, are resistant to the common strain of the fungus but not to some of the newer strains. Treat potato dumps and cull piles with a weed spray to control sprouts. Delay digging crop until 2 weeks after tops die, or else kill the tops with a weed killer to prevent infection at early digging.

Late Blight of Tomato

Although there are potato and tomato strains of *Phytophthora infestans*, each is capable of infecting the other host. Ordinarily blight starts with potatoes in midsummer; when the fungus moves over to tomatoes, it has to go through several cycles to build up a strain virulent enough to produce general blighting, and by that time the tomato season is nearly over. Now we know that it is possible for the tomato strain to winter in potato tubers and be ready to inflict damage on tomatoes with the first crop of zoospores produced on potato sprouts. Conversely, tomato seedlings brought up from the South and planted near potato fields can start an epiphytotic of late blight on potatoes.

The 1946 tomato blight saga – the one that awakened eastern gardeners to the fact that plant disease could be as important to home gardeners as to farmers – started in Florida late in November 1945. By January the disease was extremely destructive in tomato seedbeds, and it continued so intermittently whenever temperatures ranged from 60° to 70°F and relative humidity was nearly 100% for more than 15 hours. Evidence indicated spores could be wind-borne for as far as 30 miles. The wave of late blight went west to Alabama, taking 75% of the early crop, and rolled up the Atlantic

Figure 3.14 Late Blight on Tomato

Coast, reaching the Carolinas in May and Virginia and Maryland in June, again taking 75% of the early crop. It rolled into Delaware and New Jersey in July, but did not reach peak epidemic form until after an extended rainy period in August, and ended in Massachusetts in August and September.

In 1947 a blight-forecasting service was started, based on weekly graphs prepared by plotting daily the cumulative rainfall and mean temperatures and aided by reports from key pathologists in various states. If conditions are unfavorable for blight, we can save time and money by eliminating useless spraying.

Symptoms. On seedlings small, dark spots on stems or leaves are followed by death within 2 or 3 days. On mature plants blight starts with dark, water-soaked leaf spots and large, dark brown spots on fruit, with most of the leaves soon hanging lifeless and fruit rotting on the ground (see Fig. 3.14).

Control. Bordeaux mixture applied to young tomato plants will either prevent fruit setting or cause stunting. It can be used after blossoming, or a fixed copper can be substituted.

Phytophthora meadii. **Blight** and **Leaf Spots** on West Indian holly.
Phytophthora medicaginis. **Rot Root** on Medicago spp.
Phytophthora nicotianae (formerly *Phytophthora parasitica* var, *parasitica*. **Leaf, Stem and Bub Blight** on bougainvillea, dogwood, hibiscus, artillery plant, and aluminum plant. Leaf blight; on jojoba.
Phytophthora parasitica var. parasitica (see *Phytophthora nicotianae*). **Leaf, Stem and Bub Blight** on bougainvillea, dogwood, hibiscus, artillery plant, and aluminum plant. Leaf blight; on jojoba.
Phytophthora syringae. **Citrus Blight**, also on lilac, but the more common lilac blight is due to *P. cactorum*. On citrus trees leaves have semitransparent spots similar to frost damage. Other *Phytophthora* species may be present with *P. syringae* to cause brown rot of fruits. ►Rots. On lilacs large irregular leaf patches have a lighter zone at margin. There may be some defoliation.

Plectosporium

Plectosporium abacinum. **Blight** on Hydrilla.

Pyrenochaeta

Deuteromycetes, Sphaeropsidales, Sphaerioidaceae

Pycnidia dark, ostiolate, nearly globose, erumpent with a few bristles near ostiole; conidiophores simple or branched; conidia small, one-celled, hyaline, ovate to elongate; parasitic or saprophytic. See also under Rots.

Pyrenochaeta phlogis. **Stem Blight** of Phlox.

Pyricularia

Deuteromycetes, Hyphomycetes

Conidiophores long, slender, simple or rarely branched, septate, single or in tufts; conidia pyriform to nearly ellipsoid, borne singly and attached at broader end; spores hyaline, two- to three-celled; parasitic, chiefly on grasses.

Pyricularia grisea. **Leaf Blight** on creeping bent grass and buffelgrass.

Pythium

► Rots.

Pythium myriotylum. **Blight** of tomato.

Delphinella (Rehmiellopsis)

Ascomycetes, Dothideales

Perithecia single, globose, rupturing irregularly; asci in fascicles, no paraphyses; spores hyaline, two-celled.

Delphinella balsameae (formerly *Rehmiellopsis balsameae*). **Tip Blight**, **Needle Blight** of balsam fir, on native balsam fir in northern New England and on ornamental firs in southern New England and New York. Infection is in spring with needles of current season shriveled, curled, and killed, often with a dieback of terminal or lateral shoots and sometimes cankers at base of infected needles. Satisfactory control on ornamental firs has been obtained by three sprays, at 10-day intervals, of bordeaux mixture, the first application made as new growth starts.

Rehmiellopsis balsameae (see *Delphinella balsameae*). **Tip Blight**, **Needle Blight** of balsam fir, on native balsam fir in northern New England and on ornamental firs in southern New England and New York.

Rhizoctonia

Deuteromycetes, Mycelia Sterilia (Fungi Imperfecti)

Sclerotial form of some species of *Pellicularia, Corticium, Macrophomina*, and *Helicobasidium*. Young mycelium colorless, with branches constricted at points of origin from main axis, but soon colored, a weft of brownish yellow to brown strands, organized into dense groups, sclerotia made up of short, irregular, angular or somewhat barrel-shaped cells.

Rhizoctonia ramicola. **Silky Thread Blight** a southern disease similar to web blight caused by *Pellicularia koleroga*. Perennial ornamental hosts in Florida include elaeagnus, erythrina, crape-myrtle, holly, guava, pittosporum, pyracantha, Carolina jessamine, feijoa, and rhododendron. Tan spots with purple-brown margins appear on leaf blades, dead lesions on petioles

and young twigs. When leaves are abscissed, they are often held dangling and matted together by brown fungus threads. Infection recurs annually in moist weather with high daytime temperatures. The fungus winters as mycelium in leaf lesions and diseased twigs. Sclerotia are apparently lacking in this species.

Rhizoctonia sp. (teleomorph, *Aquathanatephorus pendulus*). **Blight** on water hyacinth.

Rhizoctonia sp. (teleomorph, *Thanatephorus cucumeris*). **Blight** on beet. **Needle blight** on pine.

Rhizoctonia solani. **Blight** of pistachio and *Cynodon* spp., and **Foliar Blight** of soybean.

Rhizopus

► Rots.

Rhizopus stolonifer. **Seedling Blight** on lupine; also caused by *Pleiochaeta setosa, Alternaria* sp., *Aspergillus flavus, Aspergillus niger*, and *Curvularia* sp.

Rosellinia

Ascomycetes, Xylariales

Perithecia separate, superficial from the first, carbonaceous, not beaked, ostioles papillate; spores dark, one-celled with a small groove.

Rosellinia herpotrichioides. **Hemlock Needle Blight**. Needle-bearing portions of twigs become covered on underside with a grayish brown mycelial mat; black perithecia are produced in this mat in great abundance. Ovoid, hyaline conidia are formed on *Botrytis*-like conidiophores.

Schirrhia

Ascomycetes, Dothideales, Dothideaceae

Asci usually short, cylindrical, and relatively numerous in spherical, ostiolate locules.

Scleropycnium

Deuteromycetes, Coelomycetes

Pycnidia open out to a deep cupulate or discoid structure, tough, dark or black, subepidermal or subcortical, then erumpent; spores hyaline, one-celled. Largely saprophytic on twigs, sometimes parasitic on leaves.

Scleropycnium aureum. **Leaf Blight** of mesquite.

Sclerotinia (Whetzelinia)

Ascomycetes, Helotiales, Sclerotiniaceae

Apothecia arising from a tuberoid sclerotium which, though formed free on aerial mycelium, is sometimes enclosed in natural cavities of suscept or host, as in hollow stem of perennials. Interior (medulla) of sclerotium white, completely enveloped by a dark rind; gelatinous matrix lacking. Conidia wanting but spermatia (very small microconidia) formed on sporodochia borne free or enclosed in cavities. Apothecia some shade of brown; cupulate to funnel-form; usually at maturity saucer-shaped to flat expanded; ascospores hyaline, one-celled, ovoid. Species formerly included in *Sclerotinia* but possessing monilioid conidia are now in *Monilinia*.

Botryotinia polyblastis (formerly *Sclerotinia polyblastis*). **Narcissus Fire**. A serious flower blight in England, known here on the Pacific Coast. In England overwintering sclerotia produce apothecia when *Narcissus tazetta* comes into flower, the ascospores infecting the perianth and causing flower spotting. From withered flowers numerous large conidia, germinating with several germ tubes, infect foliage, on which large sclerotia are formed late in the season. Remove infected parts immediately; spray early in the season.

Ciberinia camelliae (formerly *Sclerotinia camelliae*). **Camellia Flower Blight**, long known in Japan, first noted in California in 1938, confirmed in Georgia in 1948, although probably there several years previously, reported in Oregon in 1949, Louisiana and North Carolina in 1950, South Carolina in 1954. The blight is now widespread in Virginia, confined to certain counties in other states. It was not officially recorded from Texas until 1957 but must have been there earlier. The 1950 outbreak at Shreveport, Louisiana, is said to have started on plants brought in from Texas that probably originated in California.

Floral parts only are affected, infection taking place any time after tips of petals are visible in opening buds. Few to many brownish specks on expanding petals enlarge until the whole flower turns brown and drops. In early stages darkened veins are prominent diagnostic symptoms. When the flowers rest on moist earth, spermatia are produced on petals in shiny black masses. Hard, dark brown to black sclerotia formed at the base of petals frequently unite into a compound structure simulating petal arrangement. This compound sclerotium may be an inch or more in diameter. Although the petals do not melt when touched as do azaleas with petal blight, there is a distinctive moist feeling that helps to differentiate flower blight from frost injury. Rarely, a flower blight of camellias is caused by another *Sclerotinia* (*S. sclerotiorum*).

Sclerotia lie dormant on ground or in mulching materials until the next winter when, from January on (possibly earlier), after wet periods with rising temperature, they produce one to several apothecia on long or short stipes with brown, saucerlike discs 1/4 to 3/4 inch across, rarely up to 1 inch. Spores, discharged forcibly, are carried by wind currents to flowers, thus completing the cycle. Spores may be wind-borne at least 1/3 mile, but presumably a large proportion of them land on opening petals of the bush overhead. The sclerotia remain viable in the soil at least 2 or 3 years, sending up more apothecia each season. No conidia are known; so there is no secondary infection from flower to flower as with azalea blight. The amount of primary inoculum is very large, however. One afternoon in New Orleans I collected nearly 1000 sclerotia that were producing apothecia from under a single camellia.

Control. The first line of defense is exclusion. Most southern states have quarantines against known infected areas; they require that plants be shipped bare-rooted, with all flower buds showing color removed. Northern gardeners ordering plants for greenhouses should insist on the same precautions even without specific quarantines. Practically all outbreaks of camellia flower blight have been traced to plants shipped in cans, presumably carrying sclerotia in the soil. The disease has also appeared on flowers shipped in by air for camellia shows. Schedules should state that all specimens become the property of the show committee, to be destroyed at the end of the show; no blooms should be taken home for propagation.

Theoretically, because there is no conidial stage to spread the fungus, this should be an easy disease to eradicate, but it has not proved so in practice. Camellias have thousands of flowers produced over a period of months.

They drop into various ground covers, and it is almost impossible to find and destroy all infected blooms before rotting tissues release sclerotia into the litter. Some cities have quarantined infected properties and provided a host-free period of 2 years, during which all flower buds are removed from all camellias in the area, but this approach has been only partially successful. Various chemicals have been tried as ground treatment to inhibit formation of apothecia.

Sclerotinia camelliae (see *Ciberinia camelliae*). **Camellia Flower Blight**, long known in Japan, first noted in California in 1938, confirmed in Georgia in 1948, although probably there several years previously, reported in Oregon in 1949, Louisiana and North Carolina in 1950, South Carolina in 1954.

Sclerotinia minor. **Blight** of soybean, peanut, and Eclipta.

Sclerotinia (*Botryotinia*) **polyblastis** (see *Botryotinia polyblastis*). **Narcissus Fire**. A serious flower blight in England, known here on the Pacific Coast. **Sclerotinia rolfsii**. **Southern Blight** on St. Johnswort.

Sclerotinia sclerotiorum. **Shoot and Twig Blight** of lilac, grape, pistachio, soybean, peanut, and malaviscus; flower blight of camellia resembling that caused by *S. camelliae* but far less serious. Tuber blight and storage rot; of Trillium. This ubiquitous fungus more often causes stem rots on its many different hosts. ►Rots.

Sclerotium

Deuteromycetes, Mycelia Sterilia (Fungi Imperfecti)

Asexual fruit bodies and spores lacking; there is merely a resting body, sclerotium, made up of a compact, rounded mass of light-colored hyphae with a brown to black rind; parasitic, often on underground plant parts. *Pellicularia* has proved to be the teleomorph state for some forms.

Sclerotium bataticola. **Ashy Stem Blight**. See *Macrophomina phaseoli* under Rots.

Sclerotium hydrophilum Blight of wild rice.

Sclerotium oryzae. **Blight** of wild rice.

Sclerotium rhizodes. **White Tip Blight** of grass. ►Snowmold.

Sclerotium rolfsii. **Southern Blight**. ►*Pellicularia rolfsii*.

Septoria

Deuteromycetes, Coelomycetes

Pycnidia dark, separate, globose, ostiolate; produce in spots, erumpent; conidiophores short, conidia hyaline, narrowly elongate to filiform, several septate; parasitic, typically causing leaf spots, but also blights and blotches (see Fig. 3.9). There are about 1000 species.

Septoria apiicola (**Syn. Septoria apii** and **S. apii-graveolentis**). **Celery Late Blight**, general on celery, also on celeriac. The two species, singly or together, produce the disease known as late blight, first reported in Delaware in 1891 and since causing much crop destruction, one California county reporting half a million dollars loss from celery blight in 1908 and Michigan a million in 1915. It was not known until 1932 that two distinct species were involved.

Early symptoms are similar. Large leaf spot, due to *S. apii*, starts as a light yellow area, which soon turns brown and dies. Spots are up to 1/4 inch in diameter, with small black pycnidia. In small leaf spot, due to *S. apii-graveolentis*, the more common and destructive pathogen, pycnidia appear at the first sign of chlorotic spotting and are often outside of the indefinite margins of the spots, which are not over 2 mm. If infection is severe, the spots fuse, and the leaves turn brownish black and rot. Leaf stalks may also be infected. Pycnidia winter on seed and in plant refuse in garden and compost. A single pycnidium of the small-spot fungus has an average of 3675 spores, extruded in gelatinous tendrils. A single leaf spot may average 56 pycnidia, and a single plant may have 2000 spots. Thus there are enormous amounts of inoculum to be spread by rain, insects, people, and tools. Some years ago on Long Island, when celery was inter-cropped with spinach, it was found that workers spread blight spores on their sleeves as they cut the spinach in early morning dew. And there is a case on record where a man walked through his own blighted celery before taking a diagonal path across his neighbor's healthy field. In a few days blight showed up all along that diagonal path.

Control. The fungus usually dies in the seed coat while the seed is still viable. Using celery seed more than 2 years old obviates the necessity for treatment. Fresh seed can be soaked in hot water for 30 minutes at 118° to 120°F. Use crop rotation; do not plant near where celery was grown the year before. Spray with bordeaux mixture or a fixed copper, starting in the seedbed when plants are just out of the ground.

Septoria leucanthemi*. **Leaf Blight**, **Blotch** on chrysanthemum, shasta daisy, and oxeye daisy. The generally destructive *Septoria* on chrysanthemum is *S. chrysanthemi*. ►Leaf Spots.
Septoria petrosellini. **Leaf Blight** of parsley, similar to late blight of celery but confined to parsley.
*Recent study indicates these are one species and that the name should be *S. apiicola*.

Septotinia

Ascomycetes, Helotiales, Sclerotiniaceae

Stroma a definite, small, thin, elongate to angular black sclerotium maturing in host tissue after it has fallen to ground. Apothecia shallow cup-shaped, stipitate; spores hyaline, ovoid, one-celled. Conidial stage a *Septotis*, with hyaline spores, two or more cells, formed on sporodochia.

Septotinia podophyllina. **Leaf Blight** of may-apple, found on leaves and stalks of this plant only.

Servazziella

Ascomycetes, Amphisphaeriales

Perithecia immersed in a stroma, with long necks converging into a disc; ascospores long, filiform, hyaline; conidia on a stroma.

Cryptospora longispora (see *Servazziella longispora*). **Araucaria Branch Blight**.
Servazziella longispora (formerly *Cryptospora longispora*). **Araucaria Branch Blight**. Lower branches are attacked first, with disease spreading upward; tip ends are bent and then broken off; plants several years old may be killed. Prune off and burn infected branches.

Sirococcus

Deuteromycetes, Sphaeropsidales, Sphaerioidaceae.

Small, rounded, black, semi-immersed pycnidia with wide ostioles; conidia hyaline, fusiform, slightly constricted, 1-septate.

Sirrococcus elavigignenti-juglandacearum. **Canker** of black walnut and butternut.
Sirococcus strobilinus. **Shoot Blight** of *Picea, Abies, Pinus*, and *Tsuga* spp.

Sphaeropsis

► Cankers.

Sphaeropsis sapinea. **Shoot Blight** of pine.

Dothiora (Sphaerulina)

Ascomycetes, Dothideales

Perithecia innate or finally erumpent, not beaked; paraphyses and paraphysoids lacking; spores hyaline, several-celled.

Dothiora wolfii (formerly *Sphaerulina polyspora*). **Twig Blight** of sourwood, and oxydendron.
Dothiora taxicola (formerly *Sphaerulina taxi*). **Needle Blight** of yew.
Sphaerulina polyspora (see *Dothiora wolfii*). **Twig Blight** of sourwood, and oxydendron.
Sphaerulina taxi (see *Dothiora taxicola*). **Needle Blight** of yew.

Sporidesmium

Deuteromycetes, Hyphomycetes

Conidiophores clustered, dark, short, simple, each bearing a terminal conidium; conidia dark, quite large, muriform with many cells, oblong to ovoid; usually saprophytic, sometimes parasitic.

Alternaria scorzonerae (formerly *Sporodesmium scorzonerae*). **Salsify Leaf Blight**. Leaves have many circular ispots, varying from pin point to 1/4 inch, brown with red borders. Leaves or whole tops die; roots are small

and unsalable. The fungus winters as mycelium and spores in plant refuse. May be the same as *Alternaria tenuis*.

Sporidesmium maclurae. **Leaf Blight** of osage-orange.

Sporodesmium scorzonerae (see *Alternaria scorzonerae*). **Salsify Leaf Blight**. Leaves have many circular ispots, varying from pin point to 1/4 inch, brown with red borders.

Stemphylium

► Leaf Spots.

Stemphylium vesicarium. **Stemphylium Blight** of onions. Lesions are nondelineated, light yellow to brown, water-soaked and range in length from one centimeter to the entire leaf.

Systremma

Ascomycetes, Dothideales

Asci in locules in an elongated stroma, which is erumpent and superficial at maturity; spores light brown, two-celled. Conidial state *Lecanosticta* with brown conidia, two to four cells, formed on a conidial stroma resembling an acervulus.

Mycosphaerella dearnessii (formerly Systremma acicola). **Pine Brown Spot Needle Blight**, on southern pines, most serious on longleaf. The name and classification of the fungus has been in dispute. The conidial stage, known since 1876, was first listed as *Septoria*, later placed in *Lecanosticta*. The teleomorph state was named *Scirrhia acicola* in 1939 but later transferred to *Systremma* because of its colored spores.

Most injurious on seedlings, needle blight may also injure large trees. Small, gray-green spots on needles turn brown and form a narrow brown band, the needle tips dying. Three successive seasons of brown spot kill longleaf seedlings. The fungus is more severe on trees in unburned areas because of accumulation of inoculum. Spray seedlings in plantations with bordeaux mixture every 2 weeks from May to October or November.

Systremma acicola (see *Mycosphaerella dearnessii*). **Pine Brown Spot Needle Blight**, on southern pines, most serious on longleaf.

Thelephora

Basidiomycetes, Aphyllophorales

Fruiting body leathery, upright, stalked; pileate or fan-shaped or much lobed, or in an overlapping series; hymenium on the underside, smooth or slightly warty; spores one-celled.

Thelephora spiculosa. Stem Blight found on azalea, fern, and other ornamentals in a Maryland garden. The fungus formed a dense weft of mycelium on surface of the soil and on plants.
Thelephora terrestris. Seedling Blight, Smother. The mycelium ramifies in the soil, and the leathery fruiting body grows up around the stem of a seedling conifer or deciduous tree, smothering it or strangling it without being actually parasitic on living tissue. The disease occurs most often in crowded stands in nurseries. The damage is seldom important.

Tryblidiella

Ascomycetes, Patellariales

Apothecia opening by a wide cleft; spores dark, cylindrical, with several cells.

Rhytidhysteron rufulum (formerly *Tryblidiella rufula*). Twig Blight on citrus.
Tryblidiella rufula (see *Rhytidhysteron rufulum*). Twig Blight on citrus.

Volutella

Deuteromycetes, Hyphomycetes

Sporodochia discoid, with marginal dark setae; conidiophores usually simple, in a compact palisade; conidia hyaline, one-celled, ovoid to oblong; parasitic or saprophytic (see Fig. 3.9).

Pseudonectria pachysandricola (see *Volutella pachysandrae*, Telemorph). Pachysandra Leaf and Stem Blight. Large areas of leaves turn brown to black, along with portions of stems, and in wet weather numerous pinkish spore pustules appear along stems.

Volutella buxi. **Boxwood Leaf Blight**, **Nectria Canker**. Pinkish spore occur as pustules on leaves and twigs. Leaves often turn straw-colored. See further under Cankers.

Volutella pachysandrae (formerly, *Pseudonectria pachysandricola*). **Pachysandra Leaf** and **Stem Blight**. Large areas of leaves turn brown to black, along with portions of stems, and in wet weather numerous pinkish spore pustules appear along stems. The blight is most serious when pachysandra has been injured or is too crowded or is kept too moist by tree leaves falling into the bed. Spraying once or twice with bordeaux mixture gives excellent control if severely blighted plants have been removed before treatment. Keep pachysandra thinned and sheared back periodically.

BLOTCH DISEASES

Diseases designated as blotch have symptoms that are intermediate between blights, where the entire leaf or shoot dies, and leaf spots, where the necrotic lesions are definitely delimited. Blotches are irregular or indefinite large or small necrotic areas on leaves or fruit.

Alternaria

► Blights.

Alternaria porri. **Purple Blotch** of onion, also on garlic, and shallot, a problem in southern and irrigated areas. Small, white, circular to irregular spots increase to large purplish blotches, sometimes surrounded by orange and yellow bands, on leaves and flower stalks. Leaves often turn yellow and die beyond the spots; girdled stalks die before seeds mature. Brown muriform spores form a dusky layer on the blotches. Varieties with a waxy foliage are more resistant than those with glossy leaves. The fungus winters as mycelium and spores in crop refuse. Rotation, cleaning up plant debris, and seed treatment are recommended.
Two other species of *Alternaria, A. alternata* and *A. tenuissima*, may cause purple or brown blotches on onion, and there are physiological races as well.

Cercospora

► Blights.

Cercospora concors (see *Myrovellosiella concors*). **Potato Leaf Blotch**. An unimportant disease; leaflets turn yellow with small blackened dead areas or larger, irregular brown areas.
Cercospora purpurea (see *Pseudocercospora purpurea*). **Avocado Blotch**, **Cercospora Spot**, considered the most important avocado disease in Florida with no commercial variety entirely resistant.

Myrovellosiella concors (formerly *Cercospora concors*). **Potato Leaf Blotch**. An unimportant disease; leaflets turn yellow with small blackened dead areas or larger, irregular brown areas.

Pseudocercospora purpurea (formerly *Cercospora purpurea*). **Avocado Blotch**, **Cercospora Spot**, considered the most important avocado disease in Florida with no commercial variety entirely resistant. Leaf spots are angular, brown to chocolate brown, scattered and distinct, less than 1/16 inch or coalescing to larger patches. With a hand lens, grayish spore groups can be seen on both sides of the leaf. Successive crops of spores are produced in moist periods throughout the year. Fruit spots are 1/4 inch or less in diameter, brown to dark brown, irregular, sunken, with cracked surfaces and grayish spore tufts. Lesions are confined to the rind so that the flesh is not affected, but the cracks furnish entrance to anthracnose and other decay organisms. The fungus winters in leaves, and appears to be progressively more abundant.

Cladosporium

Deuteromycetes, Hyphomycetes

Conidiophores dark, branched variously near upper or middle portion, clustered or single; conidia dark, one- or two-celled, variable in size and shape, ovoid to cylindrical, borne singly or in chains of two or three; parasitic or saprophytic.

Cladosporium herbarum. **Leaf Blotch** of lilac. The fungus is usually secondary, saprophytic, following blights.

Cladosporium paeoniae. **Peony Leaf Blotch**, **Red Stem Spot**, **Measles**. Leaf and stem spots are purplish or brownish red. On stems the spots are raised, up to 4 mm long; on leaves the lesions are small specks. Small reddish spots are also present on floral bracts and petals. The disease is widely distributed in commercial plantings and may sometimes destroy the value of flowers for cutting. Cut down tops in fall as for Botrytis blight. Spraying the ground with Elgetol in spring before new growth starts has given good control in some fields.

Geastrumia

Geastrumia polystigmatis. **Sooty Blotch of Fruit** on apple and blackberry.

Gloeodes

Deuteromycetes, Sphaeropsidales, Leptostromataceae

Pycnidia dimidiate, having a radiate cover over the top half only, on a dark subicle or mycelial crust; pseudoparaphyses present; conidia hyaline, one-celled.

Gloeodes pomigena. **Sooty Blotch of Fruit** on apple, crabapple, blackberry, pear, and citrus, in eastern and central states down to the Gulf, rare in the West. Fruit may be infected by heavy spore dissemination from pycnidia on twigs of various wild trees, including persimmon, prickly-ash, white ash, bladdernut, hawthorn, red elm, sassafras, maple, sycamore, and willow. On apples, clusters of short dark hyphae make a superficial thallus on the cuticle, which appears as a sooty brown or black blotch, 1/4 inch in diameter. Numerous spots may coalesce to cover the apple, a condition known as cloudy fruit. Because the lesion is superficial the fruit flesh is little affected, but the grade and market value are reduced. On citrus the fungus does not penetrate the rind, and spots can be removed by gentle hand rubbing. The disease develops in cool rainy weather during the summer. To control open up the trees in the orchards to facilitate quick drying.

Guignardia

Ascomycetes, Dothideales

Perithecia immersed in substratum, stroma lacking, mouths papillate; spores hyaline unequally two-celled, with lower cell cut off just before maturity.

Guignardia aesculi. **Horse-Chestnut Leaf Blotch**, **Buckeye Leaf Blotch**, general on horse-chestnut and Ohio buckeye, sometimes on red and yellow buckeye. Large, reddish brown blotches in foliage are, usually, surrounded by a yellowish area. Numerous pin-point black dots, pycnidia, distinguish blotch from scorch due to drought. Petioles often have reddish oval spots. In a rainy season there is a good deal of secondary infection from spores spread by wind and rain. Blotches appear on nearly every leaflet with extensive defoliation. Primary infection in spring comes from ascospores developed in fallen overwinter leaves.
Control. Rake up and burn leaves in fall. Feed trees that have been defoliated for successive years.

Mycosphaerella

► Blights.

Mycosphaerella dendroides (*Cercospora halstedii*, Anamorph). **Pecan Leaf Blotch**, on pecan in the South, on hickory in East and South, a foliage disease of nursery and orchard trees. Olive green velvety tufts of conidiophores and spores appear on undersurface of mature leaves in June and July (in Florida), and yellow spots appear in corresponding areas on upper leaf surfaces. Black pimplelike perithecia are produced in the tufts about midsummer, united in groups to give the leaf a shiny black, blotched appearance after the spores are washed away. In nursery trees, defoliation, starting with basal leaves and progressing upward, may be serious. The disease is of little consequence to orchard trees unless they have been weakened by overcrowding, borer attack, or other cause. The fungus winters in fallen leaves. To control clean up fallen leaves.

Mycosphaerella diospyri. **Leaf Blotch** of Japanese persimmon.

Mycosphaerella lythracearum (*Cercospora punicae*, Anamorph). **Leaf Blotch**, **Fruit Spot** of pomegranate. The anamorph state has been thought the same as that on crape-myrtle (*Cercospora lythracearum*), but is now considered distinct. Leaf spots are circular, small, dark reddish brown to almost black, sometimes grayish brown.

Phoma

► Blackleg.

Phoma arachidicola. **Web Blotch** of peanut.

Phyllosticta

► Blights.

Phyllosticta congesta. **Leaf Blotch** of garden plum.

Phyllosticta solitaria. **Apple Blotch**, widespread on apple and crabapple in eastern states, serious in the South and in the Ozark section of Missouri, Arkansas, Oklahoma, and Texas. The disease is also called fruit blotch, dry

rot, black scab, late scab, cancer, and tar blotch. From Kansas eastward it is second in importance to apple scab. Leaf spots are very small, round, white, with a single black pycnidium in the center of each. Larger elongate lesions are formed on veins, midribs, and petioles. Leaves do not turn yellow, but they drop prematurely if spots are numerous. Cankers on twigs and branches are located at leaf nodes or base of spurs. The first season they are small, purple to olive in color; the next season this portion is tan and the new area dark purple, often slightly raised. Pycnidia formed in twig lesions wash to leaves, fruit, and new shoots, discharged only after heavy rains and in warm weather. Heavily fertilized trees are more susceptible.

Fruit blotches are brown, irregular, feathery at the margin, studded with numerous pycnidia. They afford entrance to secondary decay organisms and may develop deep cracks, but the blotch fungus itself is superficial. It winters in infected twigs and bark cankers.

Control. Secure healthy nursery stock. Some varieties, including Grimes Golden, Jonathan, Stayman Winesap, and Winesap, are rather resistant.

Septoria

► Blights.

Septoria agropyrina. **Brown Leaf Blotch** on wheat grasses.

Septoria elymi. **Speckled Leaf Blotch** on wheat grasses. A salt and pepper effect with numerous pycnidia in pale gray, tan, or fuscous lesions.

Septoria macropoda. **Purple Leaf Blotch**, general on blue grasses. Irregular blotches on blades are mottled greenish, then gray, tan or brown, finally bleached nearly white. Pycnidia are round, flattened, and light brown.

Zygophiala

Deuteromycetes, Hyphomycetes

A genus described from banana leaves in Jamaica.

Zygophiala jamaicensis. **Greasy Blotch** of carnation. A tropical fungus found causing serious losses in California greenhouses in 1953 and reported from Pennsylvania in 1957. Small, radiate patterns, resembling spider webs, appear as if dipped in oil. Leaves become brittle, turn yellow, and die prematurely. The same fungus is present as a flyspeck on apple.

BROOMRAPES

Broomrapes are parasitic seed plants like dodder and mistletoe. They are leafless herbs, of the family Orobanchaceae, living on roots of other plants and arising from them in clumps of whitish, yellowish, brownish, or purplish stems. There are 130 or more species, mostly from North Temperate regions, but few have any garden importance. The seed germinates in soil and produces a filiform plant body that grows into the ground penetrating crown or root of the host plant and forming a more or less tuberous enlargement, from which the flowering shoots arise. Such shoots may be nearly naked, clothed only with a few scattered rudimentary leaves, or they may be covered with conspicuous, overlapping scalelike leaves. The seed may remain viable in the soil several years but probably not as long as has been believed, for they can live on some weeds between crops.

Orobanche ludoviciana. **Louisiana Broomrape** on tomato and other plants, including Spanish needle and coldenia, becoming a problem in California. Tomatoes are stunted and do not produce a full crop of fruit.

Orobanche ramosa. **Branched Broomrapeh**, **Hemp Broomrape**, most serious on hemp but parasitizing tomatoes, lettuce, tobacco, eggplant, *Ganra, Melitlotus, Silene*, poppy mallow, cranesbil, *Chaerophyllum, Verbena, Coreopsis*, fleabank, engelmann daisy, and other hosts in California. In small infections destroy the aerial stems before they set seed; practice crop rotation. Deep plowing gives some control.

CANKERS AND DIEBACKS

A canker is a localized lesion or diseased area often resulting in an open wound and usually on a woody structure. Starting as a definite necrotic spot, it may girdle cane, stem, or tree trunk, killing the water-conducting tissues so that the most prominent symptom becomes a dieback. When twigs and branches die back from the tip, the condition may be a blight, with the pathogen directly invading the dying area, or it may be a secondary effect from a canker some distance below.

Aleurodiscus

Basidiomycetes, Aphyllophorales

Hymenium resupinate, of one layer, with projecting spinose or short-branching cystidia (swollen sterile cells); spores hyaline. Facultative parasite on trees.

Aleurodiscus acerina (see *Dendrothele acerina*). **Bark Patch**, widespread on maple.

Aleurodiscus amorphus. **Balsam Fir Canker**. Cankers are formed on main stems of saplings, which are sometimes killed, but the fungus is also widespread as a saprophyte on dead bark of firs and other conifers. Cankers center around a dead branch, are narrowly elliptical with a raised border; the dead bark is covered with a light-colored layer of the fungus.

Aleurodiscus oakesii. **Oak Bark Patch**, **Smooth Patch** of white oak. Irregularly circular, smooth, light gray sunken areas in bark vary from several inches to a foot across. The fungus is confined to dead bark; trees are not injured.

Dendrothele acerina (formerly *Aleurodiscus acerina*). **Bark Patch**, widespread on maple.

Amphobotrys

Deuteromycetes, Hyphomycetes

Conidiophores are long, slender, pigmented, and highly branched; clusters of conidia at apex of each branch; conidia ovoid, one-celled, hyaline.

Amphobotrys ricini. **Stem Canker** on texasweed and castorbean. Girdling stem canker; of prostrate spurge.

Apioporthe

Ascomycetes, Diaporthales

Perithecia in a black, carbonaceous stroma; spores two-celled, hyaline; conidia in cavities in a stroma.

Anisogramma anomala (formerly **Apioporthe anomala**). **Canker**, **Twig Blight** of hazelnut.
Apioporthe anomala (see *Anisogramma anomala*). **Canker**, **Twig Blight** of hazelnut.
Apioporthe apiospora. **Twig Canker**, **Dieback** of elm.

Ascospora

Ascomycetes, Sphaeriales, Sphaeriaceae

Perithecia with a subicle; paraphyses lacking; spores two-celled, hyaline.

Ascospora ruborum (*Hendersonia rubi*, Anamorph). **Cane Spot**, **Dieback** of red and black raspberry, dewberry.

Atropellis

Ascomycetes, Helotiales

Apothecia black, sessile or with short stalk; asci clavate, with longer, hairlike paraphyses; spores needlelike to slightly club-shaped, hyaline, one-celled.

Atropellis apiculata. **Twig Canker**. On southern pines.
Atropellis arizonica. **Branch and Truck Canker**. On western yellow pine.

Atropellis pinicola (syn. **A. piniphila**). **Pine Branch** and **Trunk Canker**, on western white, sugar, and lodgepole pines in Pacific Northwest and California. Branches are girdled and killed, but not the trees. Perennial cankers are smooth, elongated, flattened depressions covered with bark, in which appear very small black apothecia, 2 to 4 mm in diameter.
Atropellis piniphila (*Cenangium piniphilum*, Anamorph). **Branch and Truck Canker** on lodgepole and ponderosa pines on Pacific Coast, on cultivated pines in the South. Trees 5 to 25 years old are damaged by deformation of main stem and branches. Infection is at branch whorls. Cankers are elongated, flattened depressions covered with bark and copious resin. Apothecia have short stalks, are black with brownish discs, 2 to 5 mm across.
Atropellis tingens. **Branch and Truck Canker** of native and exotic hard pines from New England and Lake states to Gulf states. Slash pine saplings are most susceptible. Smaller branches are girdled; perennial target cankers are formed on larger branches and main stems. Cankers persist for many years, but extension stops after about 10 years.

Botryodiplodia

► Blights.

Botryodiplodia gallae (see *Lasiodiplodia theobromae*). **Canker** of oak.
Botryodiplodia theobromae. **Canker** of rose, and citrus.
Lasiodiplodia theobromae (formerly *Botryodiplodia gallae*). **Canker** of oak.

Botryosphaeria

► Blights.

Botryosphaeria dothidea. **Canker**, **Gummosis**, and **Dieback** on peach, Bradford pear, thornless blackberry, sequoiadendron and sequoia.
Botryosphaeria obtusa. **Canker**, on thornless blackberry.
Botryosphaeria ribis. Saprophytic on dying tissue, and var. **chromogena**, parasitic. **Canker**, **Dieback** of at least 50 woody plants, including apple, avocado, eucalyptus, fig, forsythia, hickory, pecan, pyracantha, quince,

rhododendron, sequoia, sequoiadendron, sweet gum, and willow. See under Blights for the disease caused on currant and rose, under Rots for apple and avocado diseases.

On redbud, sunken oval cankers nearly girdle branches, the fungus entering through wounds, and dead and dying twigs. On rhododendron there is a leaf spot and dieback similar to that caused by *Phytophthora* except that the surface is roughened by protruding fruit bodies. Cankers on twigs, larger branches, and trunks of willow may kill trees in a few years. Trunk lesions are very small, 1/4 to 1/2 inch, and numerous or else large, from the union of several small cankers, with fissured bark. Apples have watery blisters on bark and decline in vigor. Forsythia has affected canes girdled and killed with conspicuous brown dead leaves above the canker.

Control. Prune and burn dead twigs and heavily infected branches; paint wounds with a disinfectant followed by tree paint; avoid injuries. Copper sprays may help.

Botryosphaeria stevensii. Canker, on juniper.

Botrytis

► Blights.

Botrytis cinerea. Canker of rose.

Caliciopsis

Ascomycetes, Coryneliales

Stroma lobed, each lobe containing a single locule, which is finally wide open; perithecia stalked; asci on long slender stalks; spores dark, one-celled.

Caliciopsis pinea. Pine Canker on eastern white pine and other species, also on Douglas fir. Cankers are sharply depressed areas in bark, reddish brown and smoother than rest of bark, up to several inches in diameter. Small, globose, clustered black pycnidia, and stalked perithecia looking like slender black bristles, arise from stroma in cankered bark. The disease is most serious on suppressed saplings.

Encoelia (Cenangium)

► Blights.

Cenangium singulare (see *Encoelia pruinosa*). **Sooty-Bark Canker** of aspen, on *Populus tremuloides* in Rocky Mountain area.
Encoelia pruinosa (formerly *Cenangium singulare*). **Sooty-Bark Canker** of aspen, on *Populus tremuloides* in Rocky Mountain area. Cankers on older trees, at any point on trunk up to 60 to 70 feet may extend 10 to 15 feet before they girdle the tree. The bark is sooty black with a thin white outer layer.

Ceratocystis (Ceratostomella)

Ascomycetes, Micrascales

Perithecia with very long beaks, carbonaceous or leathery; ascospores hyaline, one-celled; brown, ovoid conidia and one-celled rodlike endospores formed inside tubelike conidiophores and extruded endwise. Some species are important tree pathogens; see Oak Wilt and Dutch Elm Disease under Wilts.

Ceratocystis fimbriata f. sp. platani (*Endoconidiophora fimbriata* f. sp. *platani*). **Canker Stain of London Plane, Plane Blight**, on London plane and also on American plane or sycamore. This serious disease started as a killing epidemic in the Philadelphia area about 1935, destroying city shade trees by the thousands there and in Baltimore during the next few years. The disease now extends from New Jersey to North Carolina and Mississippi. Trees show sparse foliage, smaller leaves, and elongated sunken cankers on trunks and larger branches. Cross sections through cankers reveal blue black or reddish brown discoloration of wood, usually in wedge-shaped sectors. First year cankers may not be more than 2 inches wide and a yard or so long, but they widen annually, girdling and killing trees in 3 to 5 years. Several cankers coalescing around the trunk kill more quickly. Once infection starts, the tree is doomed.
Ascospores and the two types of conidia are produced in moist spring weather (see Fig. 3.15). They may be spread by rain a short distance, but most dissemination is by man in pruning operations, and ordinary tree paint car-

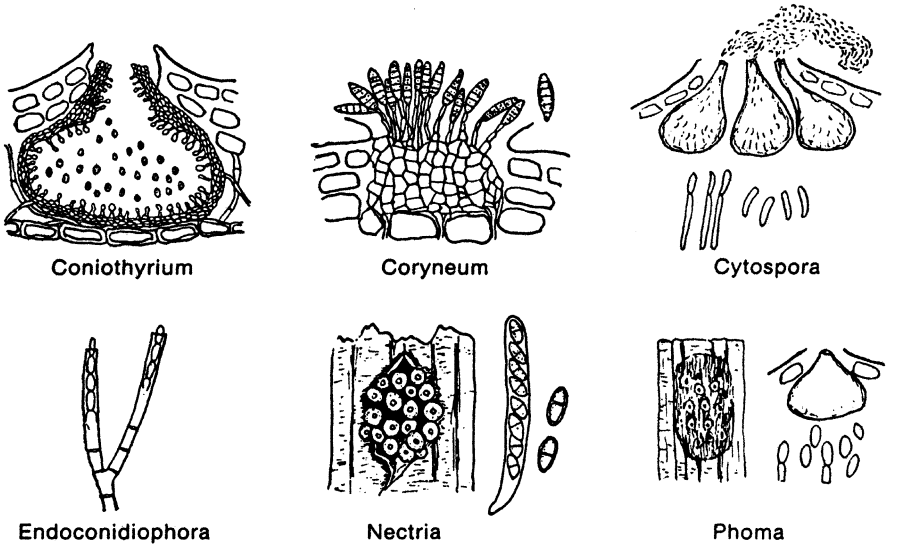

Figure 3.15 Spore Formation of Some Canker Fungi. *Coniothyrium*, small dark spores on short conidiophores in pycnidium; *Seiridium*, formerly *Coryneum*), dark, septate spores in acervulus; *Cytospora*, sausage-shaped spores in valsoid pycnidia expelled in cirrhi; *Endoconidiophora*, spores formed on inside of conidiophores; *Nectria*, two-celled bright ascospores in reddish perithecia clustered on bark; *Phoma*, hyaline spores in pyncnidia formed in spots on bark

ry viable spores. Some beetles may be vectors. Infection is solely through wounds.

Control. Do not try to save trees where trunk has been invaded; diseased branches may sometimes be removed, cutting at least 3 feet from infected area. Do not prune unless absolutely necessary and then only in winter when trees are less susceptible. Use tree wound dressing fortified with a disinfectant.

Ceratocystis sp. **Canker** and **Dieback** on poplar.

Chondropodium

Deuteromycetes, Coelomycetes

Pycnidia stromatic, stalked, columnar, externally black, hard, internally gelatinous; conidiophores simple; conidia hyaline, with several cells, crescent- or sickle-shaped; weakly parasitic or saprophytic.

Chondropodium pseudotsugae. **Bark Canker** of Douglas-fir. This is a superficial canker with outer layers of bark killed over small, circular to

elliptical areas, in which pycnidia project as short, blunt, black spines. Trees are not noticeably injured.

Colletotrichum

► Anthracnose.

Colletotrichum acutatum. **Canker** and **Dieback** on Japanese maple.

Coniothyrium

Deuteromycetes, Hyphomycetes

Pycnidia black, globose, separate, erumpent, ostiolate; conidiophores short, simple; conidia small, dark, one-celled, ovoid or ellipsoid; parasitic or saprophytic (see Fig. 3.15).

Coniothyrium fuckelii (Anamorph, *Diapleela coniothyrium*). **Rose Commom Canker**, **Stem Canker**, widespread on rose, also causing raspberry cane blight (see *Leptosphaeria* under Blights), sometimes associated with apple rots, peach cankers, and stem canker of Virginia creeper. Of the three species of *Coniothyrium* that cause rose cankers, *C. fuckelii* is by far the most common. Any plant part may be affected. Pycnidia have even been found within blackspot lesions on leaves, but this is primarily a cane disease, starting as a red or yellow spot on bark, drying out and turning brown as it increases in size, with the epidermis somewhat wrinkled and perhaps rupturing irregularly over sooty masses of very small, olive brown spores. The stem may be girdled with dieback to that point.

Stem cankers are found around insect punctures, thorn pricks, leaf or thorn scars, or abrasions caused by tying, but the majority of cankers are formed at the cut end of a cane when a stub has been left in pruning above a leaf axil or bud. Roses cut properly close to a bud seldom develop this canker. A rose stub usually dies back to the first node, and since this fungus is a weak parasite, it starts most readily in such dead or dying tissue. When a cut is made close to the node, it is quickly callused over, and the callus is a good defense against wound fungi.

Control. Prune out cankered and dying stems as soon as noticed. Make all cuts just above a bud or leaf axil, not only at spring pruning but in cutting flowers for the house or cutting off dead blooms during the season.

Coniothyrium rosarum. **Rose Graft Canker**. This is a disease of roses under glass, starting at the union of stock and scion in the warm moist propagating frame and continuing in a large amount of dead wood when plants are removed to the greenhouse bench. Some consider the pathogen a form of *C. fuckelii*. Having measured spores of the type specimen, in the Kew Herbarium, I think they are distinct species, but that some cases of graft canker are due to the common canker fungus.

Coniothyrium wernsdorffiae. **Rose Brand Canker**, a rather rare but very serious disease. The pathogen was named in Germany in 1905 and was not reported in this country until 1925, although it was subsequently shown to have been collected in Canada in 1912 and in Pennsylvania and Minnesota in 1914 and 1916. In 1926 a severe epiphytotic appeared at Ithaca, New York, in the Cornell rose garden, infecting about 90% of the climbers so seriously that the canes had to be cut to the ground. Since then it has been reported from a few other states, but in several instances it has been confused with common canker.

Small, dark reddish spots on canes enlarge and acquire a more or less definite reddish brown or purple margin, contrasting sharply with the green of the cane. The center of the spot turns light brown as the cells die, and little longitudinal slits appear over the developing pycnidia. Spores are olive brown, nearly twice the size of *C. fuckelii*, and released through epidermal slits instead of being spread in a sooty mass under the epidermis. Cankers formed under the winter protection of soil are black when roses are first uncovered in spring, which explains the name *Brandfleckenkrankheit*, meaning fire-spot disease.

C. wernsdorffiae is a cold temperature fungus, infecting rose canes under the winter covering, entering through insect wounds, thorn scars, scratches, and occasionally through dormant buds. During a 4-year investigation at Ithaca, I found no infection on canes not hilled with earth or other moist cover over winter and no natural infection during the summer.

Control. Omit the usual winter protection of soil or other materials that keep canes moist. If brand canker is a problem, just fasten canes of climbers down near the ground, uncovered, and hope for the best. Loss from winter injury will be less than from the canker. Cut out diseased canes carefully.

Seiridium (Coryneum)

► Blights.

Coryneum cardinale (see *Seiridium cardinale* (*Leptosphaeria* sp., Telemorph)). **Coryneum Canker** of Cypress, **Bark Canker** of cypress, incense ceder, common juniper and oriental arborvitae.
Coryneum foliicola. **Twig Canker**, **Fruit Rot**, widespread on apple, affecting twigs, foliage and fruit.
Seiridium cardinale (formerly *Coryneum cardinale* (*Leptosphaeria* sp., Telemorph)). **Coryneum Canker** of Cypress, **Bark Canker** of cypress, incense ceder, common juniper and oriental arborvitae. This disease, since its discovery in 1927, has been gradually exterminating Monterey Cypress in most parts of California and is also serious on Italian cypress. Twigs, branches, and whole trees turn sickly, lose their leaves, and finally die.
The fungus attacks living bark and cambium, girdling twig and branch. Cankers appear first at base of lateral twigs; they are slightly sunken, dark, resinous, rough, with black spore pustules. Conidia have dark median cells, five cross-walls (see Fig. 3.15). They are spread by tools, in nursery stock, by wind and rain, and perhaps by birds and insects. Infection appears first in upper parts of trees, usually in spring during moist weather. Yellowing and browning of foliage together with gummy ooze at the cankers form conspicuous symptoms.
Control. Drastic surgery, removing wood well below infected parts, and spraying foliage heavily with bordeaux mixture help some, but with heavy infection the price of saving healthy trees is the removal and destruction of all diseased specimens. California citizens, threatened with the loss of the famous native stands of Monterey cypress at Point Lobos and Cypress Point, voluntarily destroyed their own plantings by the thousands.

Cryphonectria

Ascomycetes, Diaporthales

Production of perithecial ascocarps produced in a stroma of fungal and substrate tissues or directly from somatic hyphae on the substrate. Ascospores are hyaline to brown and one-to-several-septate.

Cryphonectria parasitica. **Canker** on oak.

Cryptodiaporthe

Ascomycetes, Sphaeriales, Valsaceae

Like *Diaporthe* but without blackened zones in substratum; spores hyaline, two-celled.

Amphiporthe aculeans (formerly *Cryptodiaporthe aculeans*; *Sporocybe rhois*, Anamorph). **Dieback**, **Canker** of sumac.

Amphiporthe castanae (formerly *Cryptodiaporthe castanea*). **Dieback**, **Canker** of Asiatic Chestnut, widespread, chiefly on seedlings or on larger trees in poor sites. Canker starts as a brown discoloration of bark of the trunk, limb, or twig, often girdling twig and then invading larger branch. Leaves on girdled branches wilt without yellowing, turn brown, and die. Bark splitting over callus formation at edge of diseased area forms pronounced canker. Conidia, two-celled, fusoid, are formed in pustules in bark; beaked perithecia are formed in groups by midsummer.

Control. Maintain vigor; plant on well-drained, fertile soil. Prune out diseased portions several inches below affected area.

Crytodiaporthe aculeans, **Sporocybe rhois, Anamorph** (see *Amphiporthe aculeans*). **Dieback**, **Canker** of sumac.

Cryptodiaporthe castanea (see *Amphiporthe castanae*). **Dieback**, **Canker** of Asiatic Chestnut, widespread, chiefly on seedlings or on larger trees in poor sites.

Cryptodiaporthe salicella. **Twig and Branch Canker** of willow.

Cryptomyces

Ascomycetes, Rhytismatales

Apothecia effuse, splitting irregularly; paraphyses present; spores hyaline, one-celled.

Cryptomyces maximus. **Blister Canker** on common and purple osier.

Cryptosporella

Ascomycetes, Diaporthales

Perithecia in a circle in a stroma, with long necks converging in a common canal; spores one-celled, hyaline; conidia borne on surface of stroma.

Cryptosporella umbrina. **Rose Brown Canker**, a widespread and serious rose disease, first reported in Virginia in 1917 but known from herbarium specimens to have been present since 1903. The fungus was first placed in *Diaporthe* because of occasional two-celled spores.

Symptoms are most noticeable on canes, starting with very small purplish spots, the center soon turning white with a reddish purple margin (see Fig. 3.16). Many small spots may be grouped on a single cane. During the winter, and especially on portions of canes covered with earth, cankers or girdling lesions are formed, often several inches long, with tan centers and purplish borders. In moist weather the surface of these large cankers is covered with yellow spore tendrils from pycnidia just under the bark; asci are also extruded in tendrils from perithecia.

Leaf spots are small purplish specks or larger dead areas, cinnamon buff to white, bordered with purple and with black pycnidia in the center. Marginal spots are subcircular. Buds are sometimes blighted; exposed petals of flowers have cinnamon-buff spots without the purple border. Infection is through wounds and also uninjured tissue.

Control. The best time to take care of brown canker is at spring pruning. Cut out every diseased cane possible. A dormant lime sulfur spray, immediately after pruning, kills spores that may have been spread in the process and may inhibit the fungus in initial lesions. Copper or sulfur sprays largely prevent summer infections. Brown canker is more likely to be serious where roses are overprotected for winter with salt, hay, leaves, or other material added to the mound of soil. I have no trouble with brown canker when roses are left unhilled over winter.

Cryptosporella viticola. **Dead-Arm Disease** of grapes, **Branch Necrosis**, widespread, especially in the Northeast, serious in Illinois, important in California. Small, angular spots with yellowish margins and dark centers are formed on leaves, stems of flower clusters and canes. The latter may split to diamond-shaped cankers, and by the next season the arm is dead or producing yellowed, dwarfed and crimped foliage. Lesions on cluster stems advance into fruit late in the season causing rotting. Pycnidia are developed on old wood; infection is often through pruning wounds.

Control. Make pruning cuts at least 6 inches below the lower margin of the infected part. Spray with bordeaux mixture when spores are extruded.

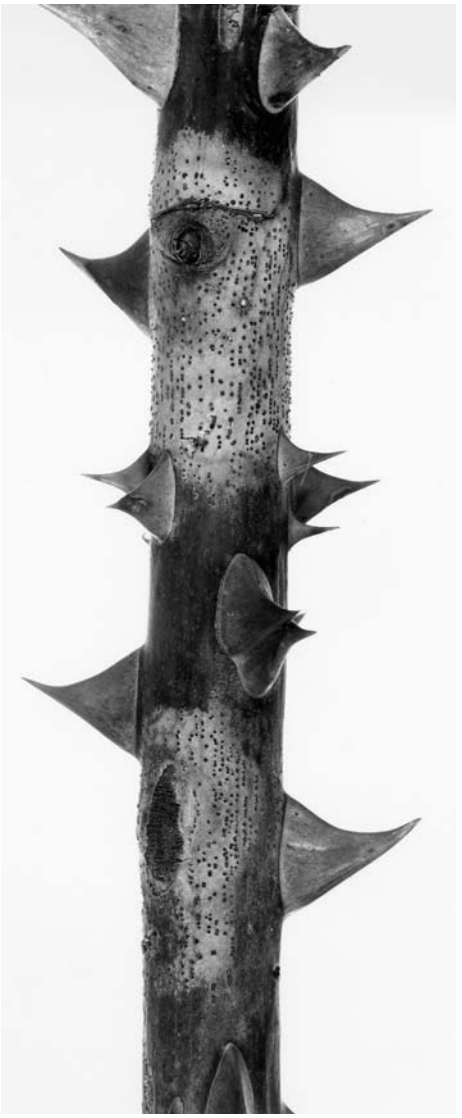

Figure 3.16 Brown Canker on Rose

Cryptosporium

Deuteromycetes, Coelomycetes

Acervuli erumpent, becoming cup-shaped or disclike; stroma brownish; conidiophores simple or branched; conidia hyaline or subhyaline, one-celled filiform.

Cryptosporium minimum. Canker on rose, not common.

Cryptosporium pinicola (see *Gelatirosporium piricola*). **Canker**, **Branch Mortality** of *Abies* spp.
Gelatirosporium piricola (formerly *Cryptosporium pinicola*). **Canker**, **Branch Mortality** of *Abies* spp.

Cylindrocarpon

► Rots.

Cylindrocarpon didymium. **Bole Canker** on apple.
Cylindrocarpon cylindroides. **Canker**, **Branch Mortality** of *Abies* spp.

Cylindrocladium

► Blights.

Cylindrocladium scoparium. **Crown Canker** of rose. The cane is attacked at or just below the union of stock and scion, the bark darkening into a black, water-soaked punky region. The cankers girdle but do not kill the canes; there are fewer and more inferior blooms. The disease was long thought confined to greenhouse roses but has appeared once or twice in outdoors fields. The fungus lives in the soil and enters through wounds in the presence of sufficient moisture. Before planting of fresh stock, greenhouse benches should be washed with boiling water and soil sterilized or changed.
The same fungus injures seedling conifers in nursery rows, causing damping-off, root rot, stem canker and needle blight to white pine and Douglas-fir. See under Blights for a discussion of the pathogen on cuttings of azaleas and other ornamentals.

Cytospora

Deuteromycetes, Coelomycetes

Cosmopolitan species, anamorph state of *Valsa*. Pycnidia in a valsoid stroma with irregular cavities, incompletely separated; conidia hyaline, one-celled, allantoid, expelled in cirrhi (see Fig. 3.15).

Cytospora abietis. **Canker**, **Branch Mortality** of *Abies* spp.
Cytospora pruinosa. **Canker**, **Dieback** of ash, on twigs and branches.

Cytospora chrysosperma (Teleomorph, *Valsa sordida*). **Cytospora Canker** of poplar, aspen, cottonwood, willow, occasional on mountain-ash, maple, cherry, and elder. Cankers form on trunks and large branches, most often on trees of low vigor. Bark is discolored in more or less circular areas; sapwood is reddish brown. In old cankers exposed wood is surrounded by layers of callus tissue. In moist weather spring spore tendrils are extruded from pycnidia in dead bark. Perithecia are found infrequently in aspen, arranged circularly around a grayish disc; they are flask-shaped with long necks pushing through the bark. Twigs and small branches may die back without a definite canker. The fungus is often present on healthy trees, not becoming pathogenic until the trees are weakened by neglect, drought, pollarding or other causes. Entrance is through wounds. Lombardy and Simon poplars are frequently killed.

Control. Remove dead and dying branches and trees with extensive cankers. Avoid wounds; feed and water as necessary. Plant poplars that are less susceptible than Lombardy. Rio Grande cottonwood is resistant to twig blight.

Cytospora kunzei (Teleomorph, *Leucostoma kunzei*). **Cutospora Canker** of spruce. **Twig Blight**, common and serious New England to the Midwest. Cankers start around bases of small twigs or on trunks. Browning and death of Colorado blue spruce branches starts near the ground and progresses upward, a large flow of resin on affected limbs. Needles drop immediately or persist for a time. Cankers are formed near resin spots and yellow tendrils extruded. Spores are splashed by rain and wind to other branches; infection is mostly through wounds.

Another form of the pathogen, *Valsa kunzei* var. *superficialis*, occurs on pine and variety *kunzei* on balsam fir, Douglas-fir, larch and hemlock.

Control. There are no satisfactory control measures except removal of diseased branches and perhaps carefully excising cankered bark. Spraying with bordeaux mixture has been recommended but is seldom very effective. Avoid wounding ornamental trees with lawn mowers; sterilize pruning tools between cuts; feed to renew vigor.

Cytospora leucostoma. **Canker** of black cherry.

Cytospora nivea. **Canker**, **Dieback** of poplar and willow, similar to that caused by *C. chrysosperma*; occasional.

Cytospora leucosperma. **Branch Canker** of elder.

Cytospora sp. **Canker** on alder and pecan.

Cytospora spp. **Cytospora Canker** of Italian Prunce, causing severe injury to prune and apricot in Idaho orchards since 1951, also present on cherries,

peach, apple and willows. Some orchards have been lost, others hard hit. Symptoms are yellow to brown flags of dead leaves and erumpent, gummy cankers or elongated necrotic streaks in the bark. All suspicious wood should be cut out, hauled out of the orchard, and burned.
► *Valsa cincta* for further discussion of cankers on stone fruits.

Dasyscyphus

Ascomycetes, Helotiales, Helotiaceae

Apothecia stalked, white and hairy on the outside with a bright disc; paraphyses filiform; asci inoperculate; spores elliptical to fusoid.

Dasyscyphus agassizi (see *Lachnellula agassizii*). Common on blister-rust lesions of white pine; saprophytic on dead branches.
Dasyscyphus calycina (*Trichoscyphella hahniana*) (see *Lachnellula subtilissima*). On larch and fir, ordinarily a saprophyte but can be a weak parasite; occasional on blister-rust cankers.
Dasyscyphus ellisiana. **Canker** of Douglas-fir and pine in eastern United States. This is a native fungus on twigs and branches of native and introduced pines and on basal trunk and branches of Douglas-fir. Bark on trunk may be infected for 10 to 15 feet, with copious resin flow and numerous swellings, but trees are not killed. Apothecia are short-stalked, covered with white hairs, with an orange to yellow disc, 2 to 4 mm across. Remove trees with trunk cankers.
Dasyscyphus pseudotsugae (see *Lachnellula pseudotsuga*). **Canker** on Douglas-fir. Swollen open cankers, 2 to 3 inches long, are formed on suppressed saplings.
Dasyscyphus resinaria (see *Lachnellula resinaria*). **Canker** on balsam fir. Swollen cankers at base of branches; younger stems girdled and killed.
Dasyscyphus willkommii (see *Lachnellula willkommii* (*Trichoscyphella willkommii* syn. *Lachnellula wilkommii*)). **European Larch Canker**. Found in Massachusetts in 1927 on nursery stock from Great Britain.
Lachnellula agassizi (formerly *Dasyscyphus agassizi*). Common on blister-rust lesions of white pine; saprophytic on dead branches.
Lachnellula pseudotsuga (formerly *Dasyscyphus pseudotsugae*). **Canker** on Douglas-fir. Swollen open cankers, 2 to 3 inches long, are formed on suppressed saplings.

Lachnellula resinaria (formerly *Dasyscyphus resinaria*). Canker on balsam fir. Swollen cankers at base of branches; younger stems girdled and killed.
Lachnellula subtilissima (formerly *Dasyscyphus calycina* (*Trichoscyphella hahniana*)). On larch and fir, ordinarily a saprophyte but can be a weak parasite; occasional on blister-rust cankers.
Lachnellula willkommii (formerly *Dasyscyphus willkommii* (*Trichoscyphella willkommii* syn. *Lachnellula wilkommii*)). European Larch Canker. Found in Massachusetts in 1927 on nursery stock from Great Britain. Infected trees were removed and the fungus not seen again until 1935, near the original location. Perennial branch or trunk cankers are flattened depressions, swollen on the flanks and on the opposite side of the stem. Neighboring bark is somewhat cracked and dark with heavy exudation of resin. Cup-shaped apothecia are 3 to 6 mm across with white hairs and orange to buff discs, very short stalks. Young trees may be killed; older trees usually survive. Frost wounds are a contributing but not an essential factor. Promptly remove all trees showing cankers; continue periodic inspection.

Dermea (Dermatea)

Ascomycetes, Helotiales

Apothecia small, brownish to black with a circular opening; innate at first, on a stromoid base, rupturing host at maturity; spores one-celled, hyaline, globose to oblong. Cup fungi (ascocarp cup-shaped); excipulum of subglobose cells; sclerotia absent.

Dermatea acerina (see *Dermea acerina*). Bark Canker of maple, occasional.
Dermatea balsamea (see *Dermea balsamea*). Twig Canker of hemlock.
Dermatea livida (see *Pezicula livida*). Bark Canker of redwood.
Dermea acerina (formerly *Dermatea acerina*). Bark Canker of maple, occasional.
Dermea balsamea (formerly *Dermatea balsamea*). Twig Canker of hemlock.
Dermea pseudotsugae. Branch Canker on fir.
Pezicola livida (formerly *Dermatea livida*). Bark Canker of redwood.

Diaporthe

► Blights.

Cryphonectria cubensis (formerly *Diaporthe cubensis*). **Canker** of *Eucalyptus* spp.
Diaporthe eres. **Canker**, **Dieback** of English holly in the Northwest. The fungus name is a species complex that may include a *Diaporthe* on rose petals and one causing a peach constriction disease.
Diaporthe cubensis (see *Cryphonectria cubensis*). **Canker** of *Eucalyptus* spp.
Diaporthe eres. **Canker**, **Dieback** of English holly in the Northwest.
Diaporthe helianthi. **Canker** of sunflower; also leaf spot of sunflower.
Diaporthe oncostoma. **Canker**, **Dieback** of black locust.
Diaporthe phaseolorum var. **caulivora**. **Canker** of painted spurge, prickly sida, redweed, morning-glory, black nightshade, jacquemontia, hemp sesbania, indigo, spiny amaranth, vetch and soybean.
Diaporthe pruni. **Twig Canker** on black cherry; *D. prunicola* on American plum.

Dichotomophthora

Deuteromycetes, Hyphomycetes

Conidiophores brown, branching dichotomous to subdichotomous, elongated, terminal branches 4–8 lobed each lobe bearing single conidium; conidia dark, ovoid to elongate–ovoid, 1 to 6 celled.

Dichotomophthora portulacae. **Stem Canker** and **Root Rot** on common purslane.

Pseudomassaria (Didymella)

► Blights.

Didymella sepincoliformis (see *Pseudomassaria sepincolaeformis*). **Dieback** of rose.
Pseudomassaria sepincolaeformis (formerly *Didymella sepincoliformis*). **Dieback** of rose.

Diplodia

► Blights.

Diplodia sp. **Rose Dieback**, sometimes after drought and other contributing factors. In Texas the disease is most evident in autumn, progressing on roses in storage or overwintering in the ground. Canes die from tip downward, often starting in the flower stem. Diseased wood turns brown or black, and is somewhat shriveled. Pycnidia are produced in dead canes. Improve general rose vigor; use fungicides as for blackspot. May also cause canker of Russian olive.
Diplodia camphorae. **Canker**, **Dieback** of camphor-tree.
Diplodia infuscans (see *Sphaeropsis hyalina*). **Ash Canker** and **Dieback**, northeastern states.
Diplodia juglandis. **Dieback**, widespread on branches of walnut.
Diplodia mutila. **Stem Canker** on Laburnum. **Branch Dieback** on juniper.
Diplodia natalensis (see *Lasiodiplodia theobromae*). **Stem Canker** of prickly-ash; **Dieback** of citrus twigs, also causing citrus stem-end rot.
Diplodia quercina. **Canker** and **Blight** of oaks.
Diplodia sophorae. **Dieback** of pagoda tree.
Diplodia sycina. **Canker**, **Dieback** of fig.
Lasiodiplodia theobromae (formerly *Diplodia natalensis*). **Stem Canker** of prickly-ash; **Dieback** of citrus twigs, also causing citrus stem-end rot.
► Rots.
Sphaeropsis hyalina (formerly *Diplodia infuscans*). **Ash Canker** and **Dieback**, northeastern states.

Discella

Deuteromycetes, Coelomycetes

Pycnidia cupulate or discoid; spores 2-celled, hyaline.

Discella carbonacea (see *Discella microsperma*). **Twig Canker** of willow.
Discella microsperma (formerly *Discella carbonacea*). **Twig Canker** of willow.

Dothichiza

Deuteromycetes, Coelomycetes

Pycnidia innate, finally erumpent; conidiophores lacking; conidia hyaline, one-celled.

Discosporium populeum (formerly *Dothichiza populea*). **Dothichiza Canker** of poplar; **European Poplar Canker**, widespread but sporadic as a branch and trunk canker. Lombardy poplars are most susceptible, but hosts include black and eastern cottonwoods, balsam, black and Norway poplars. Japanese poplars are rather resistant. Young trees in nurseries are most injured, cankers often starting around wounds. They start as slightly darker, sunken areas, often at base of twigs and limbs, and become elongated. The bark is killed to the cambium; sapwood is brown. If a stem is completely girdled, it dies; otherwise, callus formation goes on through the summer, over the canker. In time diseased bark turns brown and cracks. Spores are extruded in amber tendrils, drying to brown, and are washed to wounds in the wood.
Control. Destroy infected stock in nurseries and plantations; do not move stock from a nursery where the disease is known. Avoid pruning and other wounds so far as possible; sterilize tools between cuts. Spraying nursery trees with bordeaux mixture in spring may be helpful.
Dothichiza populea (see *Discosporium populeum*). **Dothichiza Canker** of poplar; **European Poplar Canker**, widespread but sporadic as a branch and trunk canker.

Dothiora

Ascomycetes, Pseudosphaeriales

Ascocarps hairy and phragonosporous or muriform ascospores are colored.

Dothiora polyspora (see *Sydowia dothideoides*). **Canker** of aspen.
Sydowia dothideoides (formerly *Dothiora polyspora*). **Canker** of aspen.

Dothiorella

Deuteromycetes, Coelomycetes

Pycnidia dark, globose, grouped in a subcortical stroma; conidiophores simple, short; conidia hyaline, one-celled, ovoid to ellipsoid; parasitic or saprophytic on wood.

Botryodiplodia gallae (formerly *Dothiorella quercina*). **Dothiorella Canker** of oak, very destructive to red and white oaks in Illinois, affecting twigs, branches, and occasionally trunks. Cankers are dark brown, elongated, sunken, often with cracks at the margin. Pustules of pycnidia develop in bark and erupt through cracks, spores oozing on the surface. Sapwood has dark streaks.
Dothiorella fraxinicola. **Branch Canker** of ash.
Dothiorella quercina (see *Botryodiplodia gallae*). **Dothiorella Canker** of oak, very destructive to red and white oaks in Illinois, affecting twigs, branches, and occasionally trunks.
Dothiorella sp. **London Plane Canker**, first noted in New York City in 1947. Infected trees have sparse, undersized foliage and narrow, longitudinal cankers on trunk and branches, varying from 1 to 4 inches wide and often extending from ground level to branch top. The bark is rough, deeply fissured; inner bark is brown, dry; sapwood is only superficially discolored. Branches wilt and die back.
Dothiorella ulmi. **Dieback**, **Wilt** of elm. ► Wilts.

Endothia

► Blights.

Endothia gyrosa. **Branch Canker** on oak.

Epicoccum

► Leaf Spots.

Epicoccum nigrum. **Canker** on thornless blackberry.

Eutypa

Ascomycetes, Xylariales, Diatrypaceae

Stroma effuse; perithecia with necks at right angles to surface.

Eutypa armeniacae syn. E. lata. **Cytosporina Dieback** of apricot and of grape; **Twig Canker** on cherry and chokecherry. Anamorph state report-

ed from California in 1962, perithecia in 1965. Bark cankers with gum are formed at pruning wounds.

Fusarium

►Rots.

Fusarium moniliforme var. subglutinans (see *Fusarium subglutinans*). **Pitch (Branch) Cankers** and **Shoot Dieback** on southern pine species, loblolly and pond pines.
Fusarium oxysporum. **Stem Canker** on peanut.
Fusarium solani. **Stem Canker** of sweetpotato, black walnut, oak, and poinsettia.
Fusarium subglutinans (formerly *Fusarium moniliforme* var. *subglutinans*). **Pitch (Branch) Cankers** and **Shoot Dieback** on southern pine species, loblolly and pond pines.

Fusicoccum

Deuteromycetes, Coelomycetes

Pycnidia one to several in a stroma, spherical or flattened, subepidermal, erumpent; opening separately or with a common pore; conidiophores simple, short; conidia hyaline, one-celled, fusoid; parasitic or saprophytic.

Fusicoccum amygdali. **Twig Canker** of peach, increasingly important on peaches in North Atlantic coastal area. Leaf spots are large, irregular or circular, often zonate, brown with scattered pycnidia near center. Cankers at buds and bases of young twigs result in death of the distal portions; trunks of young trees may be girdled. Infections occur throughout the season at bud scales, stipules, fruit and leaf scars. Prune only in winter.
Fusicoccum elaeagni. **Canker** on Russian-olive.

Gibberella

►Blights.

Gibberella baccata. **Twig Canker** of acacia, ailanthus, apple, boxwood, mimosa, mulberry, and also on other plants where twig blight is the most important symptom. ►Blights.

Gloeosporium

► Anthracnose.

Gloeosporium sp. **Canker** on holly.
Gloeosporium sp. (*Gnomonia rubi*, Teleomorph). **Canker** on thornless blackberry.

Glomerella

► Anthracnose.

Glomerella cingulata. **Camellia Dieback**, **Canker**, widespread; sometimes on azalea, blackberry, bittersweet, rose, raspberry, soapberry, mountain-ash, and English ivy; also causing bitter rot of apple (► Rots) and anthracnose of various hosts (► Anthracnose). Camellia tips die back; leaves wilt, turn dull green and finally brown. The stem dries out, turns brown, and there is a girdle of dead bark. Elliptical cankers are present on older wood. Infection is solely through wounds, principally leaf scars in early spring but also through bark wounded by cultivating tools or lawn mowers, frost cracks, or the graft union.
Governor Moulton, Professor Sargent, and some other varieties are rather resistant; Flora Plena, Prince Eugene Napoleon, and many others are highly susceptible. Spraying with bordeaux mixture to prevent infection through leaf and bud scars gives fair control.

Cryptosporiopsis (Glutinium)

Deuteromycetes, Coelomycetes

Pycnidia innate, without a stroma; spores borne at tip and sides of conidiophores, hyaline, one-celled.

Cryptosporiopsis pruinosa (formerly *Glutinium macrosporum*). **Canker**, **Fruit Rot** of apple.
Glutinium macrosporum (see *Cryptosporiopsis pruinosa*). **Canker**, **Fruit Rot** of apple.

Griphosphaeria

Ascomycetes, Amphisphaeriales

Perithecial wall carbonaceous, mouths papillate; spores dark, with several cells.

Discostroma corticola (formerly *Griphosphaeria corticola* (Anamorph, *Seimatosporium lichenicola*). **Rose Canker**, **Dieback**. Cankers are formed near base of canes, often showing dark glistening pustules of conidia. Occasionally when the canker has girdled the cane, a large gall forms above the lesion (see Fig. 3.17). It resembles crown gall but is apparently due to interference with downward transfer of food. Cut out infected canes.
Griphosphaeria corticola (see *Discostroma corticola* (Anamorph, *Seimatosporium lichenicola*)). **Rose Canker**, **Dieback**. Cankers are formed near base of canes, often showing dark glistening pustules of conidia.

Hendersonula

Deuteromycetes, Coelomycetes

Pycnidia black, stromata, one to several per stroma, locules occurring at different levels in stroma; conidophores long, flexuous; conidia often extruded in cirrhi; at first one-celled, hyaline to yellowish, later becoming three- to four-celled and dark.

Hendersonula toruloidea. **Canker** on *Arbutus menziesii*.

Hymenochaete

Basidiomycetes, Aphyllophorales

Pileus, fruiting structure, resupinate, of several layers, with long, stiff, usually brown setae (cystidia).

Hymenochaete agglutinans. **Hymenochaete Canker** on apple, birch, hazelnut, sweetgum, mistletoe, and various young hardwoods. When an infected dead stem comes in contact with a live one, the mycelium forms a thin leathery fruiting body around the living stem, holding it to the dead stem. This resupinate structure is deep brown in the center, with a yellow margin. The stem is constricted at the point of encirclement, and the sapling usually dies in 2 or 3 years. If the dead stem is removed before girdling,

Figure 3.17 *Discostroma Canker on Rose*

a sunken canker appears on one side, but this may be overgrown with callus and disappear. Do not leave severed stems in contact with living seedlings or saplings in nursery stands.

Hypoxylon

Ascomycetes, Xylariales

Perithecia in a pulvinate stroma, often confluent and crustose; ascospores with one cell, rarely two, blackish brown; conidia in superficial layer on surface of young stroma.

Hypoxylon mammatum. **Hypoxylon Canker** of poplar. Aspen and largetooth aspen are most commonly attacked, balsam poplar less frequently. This is usually a forest, rather than a home garden, disease. Trees less than 30 years old, growing on poor sites, are most susceptible. Trunk cankers start as small, yellow to reddish brown, slightly sunken areas, centering around a wound, there grow together to form a canker marked off by vertical cracks. The bark is mottled, gray, with black patches where the blackened cortex is exposed. Conidia appear in blisterlike stromata on first- and second-year cankers, whereas perithecia are formed on third-year cankers in hard, black stromata covered with a white pruinose coat. Ascospores are ejected in winter. Eliminate infected trees when thinning stands.

Kabatina

Deuteromycetes, Coelomycetes

Kabatina juniperi. **Blight** on eastern red cedar; conidia produced in black acervuli on discolored foliage.

Lachnellula

Ascomycetes, Helotiales

Apothecia mostly cup-shaped.

Lachnellula willkommii (Syn. *Trichoscyphello willkommii*). **Canker** of European larch (► *Dasyscypha*).

Leptosphaeria

► Blights.

Diapleella coniothyrium (formerly *Leptosphaeria coniothyrium*). **Canker** on thornless blackberry.
Leptosphaeria coniothyrium (see *Diapleella coniothyrium*). **Canker** on thornless blackberry.

Leucostoma

Leucostoma cincta. **Canker** on apple.

Macrophoma

Deuteromycetes, Coelomycetes

Like *Phoma*, with discrete pycnidia arising innately, but with much larger spores; conidia hyaline; one-celled.

Diplodia tumefaciens (formerly *Macrophoma tumefaciens*). **Branch Gall Canker** of poplar. Nearly spherical round galls, not over 1 1/2 inches in diameter, at base of twigs, which usually die; not serious.
Macrophoma candollei. Associated with **Dieback** of boxwood but apparently saprophytic only. The large black pycnidia are, however, quite striking on straw-colored leaves.
Macrophoma cupressi. **Dieback** of Italian cypress.
Macrophoma phoradendron. Defoliates mistletoe, but it grows back.
Macrophoma tumefaciens (see *Diplodia tumefaciens*). **Branch Gall Canker** of poplar.

Massaria

Ascomycetes, Pyrenulales
Spores dark, with several cells, oblong-fusiform, with mucous sheath.
Massaria platani (see *Splanchrorema platani*). **Canker**, widespread on branches of American, London, and California plane trees.
Splanchrorema platani (formerly *Massaria platani*). **Canker**, widespread on branches of American, London, and California plane trees.

Melanconis

Ascomycetes, Diaporthales

Perithecia in an immersed black stroma; paraphyses present; spores two-celled, light; conidia superficial on a stroma.

Melanconis juglandis. **Walnut Canker**, **Butternut Dieback**, widespread on butternut, also on black, Japanese, and English walnut. The disease was first described from Connecticut in 1923, but evidently was responsible for slow dying of butternuts long before that. If trees have been previously weakened, the fungus proceeds rapidly; otherwise there is the slow advance of a weak parasite. Dead limbs are sprinkled with small, black acervuli, looking like drops of ink and occasionally, in wet weather, developing spore horns of olive gray conidia. In the teleomorph state, which is rare, perithecia are embedded in the bark singly or in groups. Mycelium invades bark and wood, with a dark discoloration, and grows slowly down a branch to the trunk. When the latter is reached, the tree is doomed. In final stages trees have a stag-headed effect from loss of leaves.
Control. Remove diseased branches promptly, cutting some distance below infection; remove trees developing trunk cankers; keep the rest growing well with food and water.

Meria

Deuteromycetes, Hyphomycetes

Hyaline mycelium, branched; conidiophores simple, septate; conidia hyaline, one-celled, produced singly or in clusters.

Meria laricis, **Dieback** and **Blight**, on western larch seedlings.

Monochaetia

Deuteromycetes, Coelomycetes

Acervuli dark, discoid or cushion-shaped, subcutaneous; conidia several-celled, dark median cells, hyaline end cells, and a single apical appendage; parasitic.

Monochaetia mali (see *Seiridium unicorne*). **Canker**, **Leaf Spot** of apple.
Seiridium unicorne (formerly *Monochaetia mali*). **Canker**, **Leaf Spot** of

apple. Fungus enters through deep wounds and grows into wood, then attacks resulting wound callus and produces numerous fruiting bodies on exposed wood and callus layer. Killing of successive callus layers results in a canker similar to European apple canker. The disease is not common enough to be serious.

Nectria

Ascomycetes, Hypocreales, Nectriaceae

Perithecia bright, more or less soft and fleshy, in groups, basal portion seated on a stroma; spores two-celled, hyaline or subhyaline (see Fig. 3.15).

Nectria cinnabarina. **Dieback**, **Twig Canker**, **Coral Spot**, cosmopolitan on hardwoods, most common on maples but also found on ailanthus, amelanchier, apple, crabapple, apricot, ash, blackberry, chokecherry, beech, birch, elm, hickory, horsechestnut, mimosa, linden, paper mulberry, pear, peach, sophora, locust, and honey locust. It may also appear in stem cankers on vines and shrubs–ampelopsis, barberry, boxwood, callicarpa, cotoneaster, currant, gooseberry, fig, honeysuckle, kerria, California laurel, rose, and syringa. The fungus is widespread as a saprophyte. On ornamental trees and shrubs it is weakly parasitic, producing cankers around wounds and at base of dead branches or causing a dieback of twigs and branches.

On maple, the fungus is more pathogenic, killing twigs, small branches, young trees, and girdling larger branches. It is more frequent on Norway maple and boxelder; it may also invade red, sycamore, Japanese, and other maples. First symptoms are small, depressed, dead areas in bark near wounds or branch stubs. Conspicuous flesh-colored or coral pink sporodochia, formed in dead bark, bear conidia. Later the pustules turn chocolate brown and form pockets, in which perithecia are produced. The canker is most common in severely wounded or recently pruned trees. Sapwood has a greenish discoloration. Open cankers are eventually formed with successive rolls of callus. Remove diseased wood and bark, cutting beyond the greenish discoloration.

Nectria coccinea var. **faginata**. **Nectria Beech Bark Canker** on beech in the Northeast. The disease occurs solely in connection with the woolly beech scale insects (*Cryptococcus fagi* and *C. fagisuga*), but it has caused high mortality in Canada, killing 50% of beech stands; it is epidemic in Maine on American beech and is now present in much of New England and New York.

The scale nymphs, covered with a woolly white down, cluster thickly around cracks and wounds in bark, often making trunk and branches appear to be coated with snow. The small yellow larvae establish themselves on the bark in autumn, each inserting its sucking organ, stylet, into the living bark, which shrinks and cracks. *Nectria* enters through these cracks and kills surrounding tissue in bark and cambium. When the cells are dead, the insects can no longer obtain food; therefore, they disappear.

White pustules of sporodochia are pushed out through dead bark, bearing elongate, three- to nine-celled, slightly curved macroconidia. Red perithecia, slightly lemon-shaped, appear in clusters on the bark, often so abundant that the bark appears red. After ascospores are discharged, the upper half of the perithecium collapses and sinks into the lower. The eventual canker is a deeply depressed cavity surrounded by callus. After the cambium dies, the leaves wilt; the twigs, branches, and roots finally die.

Control. Ornamental trees can be sprayed or scrubbed to kill the insects. A dormant lime sulfur spray is very effective. Oil sprays will kill the scale but may injure beech. Late summer spraying for crawlers can supplement the dormant spray.

Nectria desmazierii (*Fusarium buxicola*, Anamorph). **Canker** and **Dieback** of boxwood (see Fig. 3.18).

Nectria ditissima. Sometimes reported but not confirmed in the United States; reports probably refer to *Nectria galligena*.

Nectria fuckeliana. **Canker** on fir.

Nectria galligena (*Cylindrosporium mali*, Anamorph). **European Nectria Canker**, **Trunk Canker**, widespread on apple, pear, quince, aspen, beech, birch, maple, hickory, Pacific dogwood, and various other hardwoods. This is one of the more important diseases of apple and pear in Europe but is less serious in this country. In eastern United States it is primarily an apple disease; on the Pacific Coast it is more common on pear.

Young cankers are small, depressed or flattened areas of bark near small wounds or at base of dead twigs or branches, darker than the rest of the bark and water-soaked. Older cankers are conspicuous and somewhat like a target, with bark sloughed off to expose concentric rings of callus. Cankers on elm, sugar maple and birch are usually circular; those on oak irregular; on basswood elongate, pointed at ends. If the canker is nearly covered with a callus roll, it indicates that the infection is being overcome.

Small red perithecia are formed singly or in clusters on bark or on wood at margin of cankers. Ascospores discharged during moist weather are dis-

Figure 3.18 Volutella Blight or "Nectria" Canker on Boxwood

seminated by wind and rain. Creamy-white sporodochia protruding through recently killed bark of young cankers produce cylindrical macroconidia and ellipsoidal microconidia. Invasion is through bark cracks or other wounds in living or dying, but not dead, wood. Infection is slow, with annual callus formation; only the smallest branches are likely to be girdled. Younger, more vigorous apple trees receiving nitrogenous fertilizer appear to be more susceptible.

Control. Remove and destroy small branches with cankers. Clean out trunk cankers and cut back to sound bark; treat with bordeaux paste. On the West Coast spray pome fruits immediately after leaf fall in autumn with bordeaux mixture to prevent infection through leaf scars.

Nectria magnoliae. **Nectria Canker**, similar to the preceding but found on magnolia and tuliptree.

Neofabraea

► Anthracnose.

Neofabraea perennans (*Gloeosporium perennans*) (see *Pezicula malicorticis*). **Perennial Canker** of apple, also bull's-eye rot of fruit.

Pezicula malicorticis (formerly *Neofabraea perennans* (*Gloeosporium perennans*)). **Perennial Canker** of apple, also bull's-eye rot of fruit. The disease is much like northwestern anthracnose. It often follows after winter injury or starts at pruning cuts where aphids congregate, or may appear after an application of wound dressing.

Nummularia

Ascomycetes, Xylariales

Stroma superficial, composed entirely of fungus elements, covered with a conidial layer when young. Perithecia flask-shaped, embedded in stroma; spores one-celled, dark.

Biscogniauxia marginata (formerly *Nummularia discreta*). **Blister Canker** of apple, crabapple, pear, mountain ash; also reported on serviceberry, birch, elm, magnolia, and honey locust. This is a major apple disease east of the Rocky Mountains, especially in Upper Mississippi and Lower Missouri River valleys, where millions of apple trees have been killed. Large and small limbs are affected. Cankers are dead areas, up to 3 feet long, mottled with living wood and dotted with numerous round cushions of stromata, looking like nailheads. Perithecia, with dark ascospores, are buried in the stromata; hyphae bearing small, light-colored conidia grow over the surface. The fungus enters through branch stubs, bark injuries, and other wounds.
Control. Avoid especially susceptible varieties like Ben Davis. Shape trees early to prevent large pruning wounds on older trees; the canker seldom appears on trees less than 10 years old. Shellac pruning cuts immediately; sterilize tools between cuts.
Nummularia discreeta (see *Biscogniauxia marginata*). **Blister Canker** of apple, crabapple, pear, mountain ash; also reported on serviceberry, birch, elm, magnolia, and honey locust.

Ophionectria (Scoleconectria)

Ascomycetes, Hypocreales

Perithecia red to white, globoid, with a round ostiole, superficial, paraphyses lacking; spores needle-shaped to filiform, light colored.

Ophionectria balsamea (see *Thyronectria balsamea*). **Bark Canker** of balsam fir.

Ophionectria scolecospora (see *Scoleconectria cucurbitula*). **Bark Canker** of balsam and alpine firs.
Scoleconectria cucurbitula (formerly *Ophionectria scolecospora*). **Bark Canker** of balsam and alpine firs.
Thyronectria balsamea (formerly *Ophionectria balsamea*). **Bark Canker** of balsam fir.

Penicillium

Deuteromycetes, Hyphomycetes

Conidia in heads; conidiophores unequally verticillate at tip in whorls; globose conidia formed in chains, one-celled, hyaline or brightly colored in mass; parasitic or saprophytic.

Penicillium vermoeseni. **Penicillium Disease** of Ornamental palms, serious in southern California with symptoms varying according to type of palm. On queen palm (*Arecastrum* or *Cocos plumosa*) the disease is a trunk canker, which may remain inconspicuous for several years but leads to weakening and breaking of trunk. Infected trees should be removed at an early stage. On Canary date palm the disease is a leafbase rot, and on Washington a bud rot. ►Rots.

Pezicula

Ascomycetes, Helotiales
Apothecia similar to *Dermatea* but lighter.
Pezicula carpinea. **Bark Canker** of hornbeam.
Pezicula corticola. **Superficial Bark Canker** and **Fruit Rot**, rather common on apple and pears. Hyaline, one-celled conidia of the *Myxosporium* stage are formed in acervuli.
Pezicula pruinosa. **Canker** on branches of amelanchier.

Phacidiella

Ascomycetes, Helotiales

Asci borne in hymenial layers, covered with a membrane until mature, then splitting; apothecia remain embedded in a stroma; paraphyses present; asci clavate.

Phacidiella coniferarum (Anamorph, *Phacidium coniferarum*). **Phomopsis Disease** of conifers. The fungus is usually saprophytic, but it is parasitic on Douglas-fir and larch in Europe and on living pine in Maine.

Phomopsis

► Blights.

Phacidiopycnis boycei (formerly *Phomopsis boycei*). **Phomopsis Canker** of lowland white fir. Branches or main stem of saplings may be girdled and killed; there is often swelling at base of canker where dead tissues join living. The reddish brown needles of dead branches are prominent against living foliage.
Phacidiopycnis piri (Teleomorph, *Potabiamyces pyri*, formerly *Phomopsis discolor*). Pear branch canker and fruit rot.
Phomopsis alnea. **Canker** of European black alder.
Phomopsis amygdali. **Branch Dieback** on almond.
Phomopsis boycei (see *Phacidiopycnis boycei*). **Phomopsis Canker** of lowland white fir.
Phomopsis discolor (see *Phacidiopycnis piri*, see Teleomorph, see *Potabiamyces pyri*). Pear branch canker and fruit rot.
Phomopsis elaeagni (Syn. *Phomopsis arnoldia*). **Canker** of Russian-olive.
Phomopsis gardeniae. (Teleomorph, *Diaporthe gardeniae*). **Gardenia Canker**, **Stem Gall**, widespread in greenhouses. Although not reported until about 1933, this seems to be the most common gardenia disease. Symptoms start with brown dead areas on stem, usually near the soil line. The canker is first sunken, then, as the stem enlarges, swollen with a rough, cracked outer cork. The stem is bright yellow for a short distance above the canker, a contrast to its normal greenish white. When stems are completely girdled, the foliage wilts and dies; the plant may live a few weeks in a stunted condition. Flower buds fall before opening. When humidity is high, black pycnidia on cankers exude yellowish spore masses. Entrance is through wounds; spores may be spread on propagating knives. Infection often starts at leaf joints at the base of cuttings after they have been placed in a rooting medium. Because the cankers may be only slightly visible on rooted cuttings, the disease may be widely distributed by the sale of such cuttings.

Control. Use sterilized rooting medium. Use steam for a sand and peat mixture. Destroy infected plants; sometimes it is possible to wait until blooms are marketed.

Phomopsis lirella (Teleomorph, *Diaporthe vincae*). **Canker**, **Dieback** of vinca, and periwinkle.

Phomopsis lokoyae. **Phomopsis Canker** of Douglas-fir mostly on saplings in poor sites in California and Oregon. Long, narrow cankers, somewhat pointed at ends, develop during the dormant season after young shoots are infected. If the tree is not girdled during the first season, the canker heals over.

Phomopsis mali. **Bark Canker** of pear, and apple. The bark is rough.

Phomopsis padina (Telomorph, *Diaporthe decorticans*). **Canker**, **Twig Blight** of sour cherry.

Phomopsis sp. **Shoot Dieback** on peach.

Phragmodothella

Ascomycetes, Dothideales

Asci in locules immersed in groups in a cushionlike stroma; spores hyaline, many-celled.

Dothiora ribesia (formerly *Phragmodothella*). **Dieback**, **Black Pustule** on currant, flowering currant, and gooseberry.

Phragmodothella ribesia (see *Dothiora ribesia*). **Dieback**, **Black Pustule** on currant, flowering currant, and gooseberry.

Physalospora

► Blights.

Botryosphaeria corticis (formerly *Physalospora corticis*). **Blueberry Cane Canker**, in Southeast on cultivated blueberries. The fungus enters through unbroken bark, probably through lenticels, with cankers starting as reddish, broadly conical swellings, enlarging the next year to rough, black, deeply fissured cankers that girdle the shoots. The portions above cankers are unfruitful and finally die. Avoid very susceptible varieties like Cabot and Pioneer.

Botryosphaeria obtusa (formerly *Physalospora obtusa* (*Sphaeropsis malorum*)). **Dieback**, **Canker** of hardwoods, New York Apple-Tree Canker,

Black Rot of Apple. The fungus attacks leaves, twigs, and fruits, is more important east of the Rocky Mountains, and is found on many plants, including alder, ampelopsis, birch, bignonia, bittersweet, callicarpa, catalpa, ceanothus, chestnut, currant, cotoneaster, hawthorn, Japanese quince, maple, peach, pear, and persimmon. On hardwoods the canker is similar to that caused by *P. glandicola* on oaks. Limbs are girdled with large areas of rough bark with numerous protruding black pycnidia. For the fruit rot phase of this disease ►Rots.

Botryosphaeria quercuum (formerly *Physalospora glandicola* (*Sphaeropsis quercina, Anamorph*)). **Sphaeropsis Canker**, **Dieback** of red, chestnut, and other oaks. Shade and ornamental trees of all ages may be killed. Infection may start anywhere through wounds but more often on small twigs and branches, passing to larger branches and trunk. Twigs and branches die; leaves wither and turn brown; infected bark is sunken, and wrinkled, with small black pycnidia breaking through. On larger stems the bark has a ridge of callus around the canker, the sapwood in this area turning dark with black streaks extending longitudinally for several inches. Numerous water-sprouts grow from below the dead crown. The fungus winters on dead twigs, producing a new crop of conidia in spring, readily infecting most trees weakened by unfavorable environmental conditions.

Control. Prune out diseased portions at least 6 inches below cankers. Fertilize and water to improve vigor. Remove seriously diseased trees.

Botryosphaeria rhodina (formerly *Physalospora rhodina*). **Black Rot Canker** of tung in Mississippi and Louisiana. Black, sunken cankers on trunks, limbs, twigs, and shoots, may girdle and kill trees. Rogue and burn diseased specimens.

Glomerella cingulata (formerly *Physalospora miyabeana*). **Willow Black Canker**, accompanying scab to form the disease complex known as willow blight in New England and New York. Starting in leaf blades, the fungus proceeds through petioles into twigs; it also causes cankers on larger stems, followed by defoliation. Pinkish spore masses of the anamorph *Gloeosporium* state are formed on dead twigs and branch cankers and then short-necked perithecia, which overwinter. Remove and destroy dead twigs and branches during the dormant period. Spray 3 times with bordeaux mixture, starting just after leaves emerge in spring.

Physalospora cortices (see *Botryosphaeria corticis*). **Blueberry Cane Canker**, in Southeast on cultivated blueberries.

Physalospora glandicola (*Sphaeropsis quercina, Anamorph*) (see *Botryosphaeria quercuum*). **Sphaeropsis Canker**, **Dieback** of red, chestnut, and other oaks.
Physalospora miyabeana (see *Glomerella cingulata*). **Willow Black Canker**, accompanying scab to form the disease complex known as willow blight in New England and New York.
Physalospora obtusa (*Sphaeropsis malorum*) (see *Botryosphaeria obtusa*). **Dieback**, **Canker** of hardwoods, New York Apple-Tree Canker, Black Rot of Apple.
Physalospora rhodina (see *Botryosphaeria rhodina*). **Black Rot Canker** of tung in Mississippi and Louisiana.

Phytophthora

► Blights.

Phytophthora cactorum. **Bleeding Canker** of maple, beech, birch, elm, horsechestnut, linden, oak, sweetgum, and willow; **Crown Canker** of dogwood; **Dieback** of rhododendron; Trunk Canker of apple, almond, apricot, cherry, and peach.
Bleeding Canker, first noticed in Rhode Island on maple about 1939 and found in New Jersey the next year, is now present on many trees in the Northeast. The most characteristic symptom is the oozing of a watery light brown or thick reddish brown liquid from fissures in bark at the root collar and at intervals in trunk and branches. When dry, this sap resembles dried blood, hence the name, bleeding canker. Sunken, furrowed cankers are more definite on young trees than on older trees with rough bark. Symptoms are most prominent in late spring and early fall, with trees in moist situations most often affected. The fungus lives in the soil and advances upward from a primary root infection. Wilting of leaves and blighting of branches is evidently from a toxin. Mature trees have fewer, smaller, yellow-green leaves, and there is an acute dieback of branches. Reddish-brown areas with intense olive-green margins are found in wood extending vertically from roots to dying branches, marked at irregular intervals with cavities containing the watery fluid.
Control. Although there is no real "cure," injecting trees with Carosel, a mixture of helione orange dye and malachite green, has inhibited the fungus and

neutralized the toxin. In some cases trees recover without treatment. Avoid heavy feeding; this seems to encourage the spread of disease and causes chronic cases to become acute.

Crown Canker, collar rot, is the most serious disease of dogwood reported in New York, New Jersey, and Massachusetts. The first symptom is a general unhealthy appearance, with leaves smaller and lighter green than normal, turning prematurely red in late summer. Leaves may shrivel and curl during dry spells (normal leaves often do likewise). Twigs and large branches die, frequently on one side of the tree. The canker develops slowly on the lower trunk near the soil level. Inner bark, cambium and sapwood are discolored; the cankered area is sunken; the bark dries and falls away, leaving wood exposed. Trees die when the canker extends completely around the trunk base or root collar. The fungus lives in the soil in partially decayed organic matter, and spores are washed to nearby trees. Entrance is through wounds. The disease affects transplanted dogwoods, seldom natives growing in woods.

Control. Transplant carefully, avoiding all unnecessary wounds; avoid hitting base with lawnmower, by using a wire guard around the tree. It is difficult to save trees already infected, but cutting out small cankers and painting the wound with bordeaux paste is worth trying. If trees have died from crown canker, do not replant with dogwoods in the same location for several years.

Rhododendron Dieback, is a disease in which terminal buds and leaves turn brown, roll up, and droop as in winter cold. A canker encircles the twigs, which shrivel with the terminal portion wilting and dying. In shady locations leaves have water-soaked areas, changing to brown, zonate spots. Do not plant rhododendrons near lilacs, for they are blighted by the same fungus. Prune diseased tips well below the shriveled part, and spray after blooming with bordeaux mixture, two applications 14 days apart.

Trunk Canker of Apple, is an irregular canker often involving the entire trunk and base of scaffold branches, the first outward symptom a wet area on bark. Trees must be 5-years old or older for infection. Grimes Golden and Tomkins King are especially susceptible, often being completely girdled.

Phytophthora cinnamomi. **Basal Canker** of Maple, particularly Norway maple. Trees have a thin crown, fewer and smaller leaves, and die a year or two after cankers are formed at the base of the trunk. Sapwood is reddish brown; the roots decay. Remove diseased trees. Plant new Norway maples in good soil, well drained, rich in organic matter; treat injuries at base of

trunk promptly. See under Rots and Wilts for other manifestations of this pathogen.

Phytophthora syringae. **Pruning Wound Canker** of almond.

Plenodomus

Deuteromycetes, Coelomycetes

Pycnidia dark, immersed, irregular in shape and opening irregularly; conidia hyaline, one-celled, oblong; parasitic.

Aposphaeria fuscomaculans (formerly *Plenodomus fuscomaculans*). **Canker** on apple.

Plenodomus fuscomaculans (see *Aposphaeria fuscomaculans*). **Canker** on apple.

Pseudonectria

Ascomycetes, Hypocreales

Perithecia superficial, blight-colored, smooth; spores one-celled, hyaline.

Pseudonectria rouselliana. **Nectria Canker** of boxwood, **Leaf Cast**, **Twig Blight**. The perithecia are formed on dead leaves, but the fungus is thought to be the teleomorph state of *Volutella buxi*, which see.

Pseudovalsa

Ascomycetes, Diaporthales

Perithecia in a stroma; spores dark, with several cells.

Pseudovalsa longipes. **Twig Canker** on coast live oak and white oak.

Rhabdospora

Deuteromycetes, Coelomycetes

Pycnidia separate, not produced in spots, erumpent, ostiolate; conidiophores short, simple conidia hyaline, filiform to needle-shaped, with several cells; parasitic or saprophytic.

Rhabdospora rubi (see *Septocyta ruberum*). **Cane Spot**, **Canker** of raspberry.
Septocyta ruberum (formerly *Rhabdospora rubi*). **Cane Spot**, **Canker** of raspberry.

Scleroderris

Ascomycetes, Helotiales

Apothecia black, opening with lobes, crowded together or with a stroma, short-stalked; spores hyaline, elongate, with several cells.

Ascocalyx abietina (formerly *Scleroderris lagerbergii* = *Gremmeniella abietina*). **Canker** on pine.
Grovesiella abieticola (formerly *Scleroderris abieticola*). **Canker** of balsam fir, on Pacific Coast. An annual canker, starting in autumn and ceasing when cambium is active in spring, is formed on twigs, branches, and trunks of saplings. Only twigs and small branches are girdled, and if this does not happen before spring, the wound heals over. Small black apothecia with short stalks appear on dead bark. Ascospore infection is through uninjured bark or leaf scars.
Scleroderris abieticola (see *Grovesiella abieticola*). **Canker** of balsam fir, on Pacific Coast.
Scleroderris lagerbergii Syn. *Gremmeniella abietina* (see *Ascocalyx abietina*). **Canker** on pine.
Scleroderris lateritium. **Canker** on pine.

Sclerotinia

► Blights.

Sclerotinia (Syn. *Whetzelinia*) **sclerotiorum**. **Basal Canker** on Euonymus. **Stem Canker** and **Wilt** on sage.

Septobasidium

Basidiomycetes, Septobasidiales

All species are on living plants in association with scale insects; the combination causes damage to trees. Fungus body variable, usually resupinate, dry, crustaceous or spongy, in most species composed of subiculum growing over bark; a middle region of upright slender or thick pillars of hyphae supports the top layer, in which hymenium is formed. Basidium transversely septate into two, three, or four cells, rarely one-celled; basidiospores elliptical, colorless, divided into two to many cells soon after formation, budding with numerous sporidia if kept moist. Some species with conidia.

The fungus lives by parasitizing scales, obtaining food via haustoria. The insects pierce the bark to the cambium, sometimes killing young trees. The fungus kills a few scales but protects many more in its enveloping felty or leathery covering, a symbiotic relationship. Spores are spread by scale crawlers and by birds. Most felt fungi are found in the South, abundant on neglected fruit, nut, or ornamental trees, rare on those well kept.

Septobasidium burtii. **Felt Fungus** on southern hackberry, beech, pear, apple, and peach. This is a perennial growth, with a new ring added to the patch each summer. Probasidia are formed during the winter, and four-celled basidia in spring.

Septobasidium castaneum. **Felt Fungus** abundant on willow and water oaks, and holly; may injure azaleas. The surface is smooth, shiny, chocolate brown to nearly black.

Septobasidium curtisii. **Felt Fungus**, widespread on many trees in the Southeast, commonly on sour gum (tupelo) and American ash, also on hickory, hawthorn, Japanese quince, and others. The felt, purple-black throughout, is mounded over the insects.

Septobasidium pseudopedicellatum. **Felt Fungus**, on citrus twigs, sometimes on main stem or branches of hornbeam. Surface is smooth, buff-colored over dark brown pillars.

Solenia (Henningsomyces)

Basidiomycetes, Aphyllophorales

Fruiting layers erect, cylindrical, formed in groups, membranous.

Cyphellopsis anomala (formerly *Solenia* (*Henningsomyces*) *anomala*). **Bark Patch**, **Canker**, widespread on alder.

Merismodes ochracea (formerly *Solenia ochracea*). **Bark Patch** of birch, hornbeam, hickory, and alder.
Solenia (***Henningsomyces***) **anomala** (see *Cyphellopsis anomala*). **Bark Patch**, **Canker**, widespread on alder.
Solenia ochracea (see *Merismodes ochracea*). **Bark Patch** of birch, hornbeam, hickory, and alder.

Sphaeropsis

Deuteromycetes, Hyphomycetes

Pycnidia black, separate or grouped, globose, erumpent, ostiolate; conidiophores short; conidia large, dark, one-celled, ovate to elongate, on filiform conidiophores. Some species have *Physalospora* as the teleomorph state.

Sphaeropsis sapinea. **Bleeding Canker** on pine.
Sphaeropsis tumefaciens. **Canker** and **Gall** on *Carissa*.
Sphaeropsis ulmicola. **Sphaeropsis Canker** of American elm. The disease spreads downward from small twigs to larger branches with a brown discoloration of wood just under the bark. Secondary shoots sometimes develop below the cankers. Trees weakened by drought or poor growing conditions are particularly susceptible. Prune out infected wood, cutting well below cankers.

Stegonsporium

Deuteromycetes, Hyphomycetes
Stegonsporium sp. **Maple Canker**, **Dieback**. Reported from New Jersey. Large branches die back with conspicuous flagging. Black tarlike fruiting bodies are formed in cankers.

Strumella

Deuteromycetes, Hyphomycetes

Sporodochia wartlike, gray to black, of interwoven hyphae; conidiophores dark, branches; conidia dark, one-celled, ovoid to irregular.

Conoplea globosa (formerly *Strumella coryneoidea*). **Strumella Canker** of oak, especially the red oak group, also on American beech and chestnut,

occasional on pignut and hickories, red maple, and tupelo. Primarily a forest disease, this canker may become important on red and scarlet ornamental oaks. Starting as a yellowish discoloration of bark around a dead branch or other point of infection, the canker develops into a diffuse lesion or into a target canker with concentric rings of callus. Whitish mycelium is present near outer corky bark, and the infected portion of the trunk may be flattened or distorted. Target cankers may be up to 2 feet wide and 5 feet long. The small black nodules bear no spores while trees are living, but after death dark brown spore pustules are formed, which blacken with age. New pustules are formed yearly. Canker eradication has been unsuccessful in forest stands. The diseased trees should be removed and utilized before spores can spread infection.

Strumella coryneoidea (see *Conoplea globosa*). **Strumella Canker** of oak, especially the red oak group, also on American beech and chestnut, occasional on pignut and hickories, red maple, and tupelo.

Sydowia

Ascomycetes, Dothidiales

Asci usually short, cylindrical, and relatively numerous, in spherical, ostiolate locules.

Sydowia polyspora. **Twig Dieback** on fir.

Thyronectria

Ascomycetes, Hypocreales

Stroma valsoid with several perithecia, bright-colored; spores muriform, hyaline to subhyaline.

Thyronectria austro-americana. **Canker**, **Wilt** of honeylocust. Slightly depressed cankers ranging from pinhead size to 1/2 inch grow together and enlarge to girdle a branch. Underlying wood is streaked reddish brown for several inches from the canker, and there is often a gummy exudate. Some trees die, but many survive.

Thyronectria balsamea. **Canker** on fir.

Thyronectria berolinensis. **Cane Knot Canker** of fruiting and flowering currants.

Trichothecium

► Rots.

Trichothecium roseum. **Canker** of rose.

Tubercularia

Deuteromycetes, Hyphomycetes

Forms bright colored cushions, mostly on wood or bark; fine branching conidiophores bearing small, elipsoidal hyaline conidia.

Tubercularia ulmea. **Canker** on Russian olive and honeylocust.

Tympanis

Ascomycetes, Helotiales, Helotiaceae

Ascocarp cup-shaped; sclerotia absent; expiculum usually, if parallel hyphae.

Tympanis confusa. **Canker** on pine.

Valsa

Ascomycetes, Diaporthales

Many perithecia in a circle in a stroma in bark; flask-shaped with long necks opening to the surface; spores hyaline, one-celled, curved, slender.

Leucostoma cincta (formerly *Valsa cincta*). **Perennial Canker** of peach, **Dieback**, also on nectarine. The fungus is apparently infective during the dormant season, entering through wounds, dead buds, leaf scars, and fruit spurs. It forms a canker complex with *V. leucostoma* and sometimes the brown-rot fungus. It is more common in northern latitudes than in southern, but is not important in well-cared-for orchards.

Leucostoma kunzei (formerly Valsa kunzei). ► *Cytospora kunzei*.

Leucostoma persoonii (formerly *Valsa leucostoma*). **Apple Canker**, **Dieback**, **Twig Blight** on apple, apricot, peach, pear, quince, plum, cherry, willow, and mountain-ash. The fungus is a weak parasite entering through wounds or twigs killed by frost.

Valsa cincta (see *Leucostoma cincta*). **Perennial Canker** of peach, **Dieback**, also on nectarine. **Valsa kunzei** (see *Leucostoma kunzei*). ► *Cytospora kunzei*.
Valsa leucostoma (see *Leucostoma persoonii*). **Apple Canker**, **Dieback**, **Twig Blight** on apple, apricot, peach, pear, quince, plum, cherry, willow, and mountain-ash. **Valsa salicina** (*Cytospora salicis*). **Twig and Branch Canker** of willow.
Valsa sordida. ► *Cytospora chrysosperma*.

Vermicularia

Deuteromycetes, Coelomycetes

Like *Colletotrichum* but setae are scattered throughout the acervuli, not just marginal; spores hyaline, globose to fusoid.

Vermicularia ipomoearum. **Stem Canker** of morning glory.

Volutella

► Blights.

Volutella buxi. **Boxwood "Nectria" Canker**, **Volutella Blight**. The teleomorph state of the fungus is supposed to be *Pseudonectria rouselliana*, which see. As a canker the disease often follows after winter injury, with salmon-pink spore pustules on dying twigs, branches, and main stems. As a blight, the fungus spreads rapidly in moist weather in summer, attacking healthy twigs when humidity is high and often discernible at a distance by a straw yellow "flag." On such yellowing branches the backs of leaves and the bark of twigs are both covered with the pinkish spore pustules.
Control. Cut out branches where the bark has been loosened by winter ice and snow. Have a yearly "housecleaning," brushing out accumulated leaves and other debris from interior of bushes and cutting out all twigs with pink pustules. If there are signs of disease, follow cleaning with thorough spraying, from ground up through interior of bushes, with lime sulfur.

CLUB ROOT

Plasmodiophora

Plasmodiophoromycetes, Plasmodiophorales

This genus, founded on the club root organism, has a somewhat doubtful taxonomic position. Formerly considered a slime-mold, one of the Myxomycetes, then placed in the Chytridiales, lowest order of true fungi, it is now placed in a separate order, Plasmodiophorales.

Thallus amoeboid, multinucleate in host cell; spores lying free in host cell at maturity; frequently causing hypertrophy; parasitic on vascular plants.

Plasmodiophora brassicae. Club Root of cabbage and other crucifers; finger-and-toe-disease, on alyssum, brussels sprouts, cabbage, Chinese cabbage, candytuft, cauliflower, hesperis, honesty, peppergrass, garden cress, mustard, radish, rutabaga, stock, turnip, and western wallflower.

Club root was present in western Europe as early as the thirteenth century, but the true cause was not known until the classic paper of the Russian Woronin in 1878. The disease was important in the United States by the middle of the nineteenth century, and is now present in at least 37 states. Losses come from death of the plants and also from soil infestation, for susceptible crucifers cannot be grown again on the same land for several years, unless it is treated. The first symptom is wilting of tops on hot days, followed by partial recovery at night; affected plants may be stunted and not dead; outer leaves turn yellow and drop. The root system becomes a distorted mass of large and small swellings, sometimes several roots swollen like sweet potatoes, and sometimes joined in one massive gall. Lateral and tap roots are scabby and fissured, with rot starting from secondary fungi.

When diseased roots decompose, small spherical spores are liberated in the soil; they are capable of surviving there many years between crops. In spring, with suitable temperature and moisture, the resting spores germinate, each

becoming a motile swarm spore with a flagellum. This whiplike appendage is soon lost, and the organism becomes amoebalike, moving by protoplasmic streaming until it reaches a root hair or other root tissue. The plasmodium continues to grow and divide until it reaches the cambial cells, in which it develops up and down the root. The swelling is produced by division of plasmodia and of the infected cells. Eventually the multinucleate plasmodium breaks up into many small resting spores, each rounded up around a single nucleus. They are set free by the millions when the root rots, and are spread in soil clinging to shoes or tools and in drainage water, manure, and plant refuse. Spores are not seed-borne. Long-distance spread is probably by infected seedlings. Infection takes place chiefly in a neutral to acid soil, pH 5.0 to 7.0, at temperatures below 80°F, and when moisture of soil is above 50% of its water-holding capacity.

Control. Inspect seedlings carefully before planting. Dispose of infested crops with caution; resting spores passed through animals are still viable. A long rotation of crops has been recommended, combined with adding lime to soil, which must be applied in large amounts, about 6 weeks before the cabbage crop is set. This brings the pH too high to use potatoes as a following crop. Most turnip and rutabaga varieties are relatively resistant to strains of the club root organism present in the United States.

DAMPING-OFF

Damping-off is the destruction of young seedlings by soil organisms. There are two types. Pre-emergence damping-off rots the sprouting seed before it breaks through the soil; it is recognized by bare spaces in what should be uniform rows. Such a poor stand may be due to poor viability of seed, but more often it is due to soil fungi functioning in cold, wet soils when germination is slow. Post-emergence damping-off is the rotting or wilting of seedlings soon after they emerge from the soil. Succulent stems have a water-soaked, then necrotic and sunken, zone at ground level; the little herbaceous plants fall over on the ground or, in woody seedlings, wilt and remain upright. Root decay follows. This type of damping-off is most common in greenhouses or outdoors in warm humid weather and where seedlings are too crowded. Tree seedlings in nursery rows are subject to this type of damping-off, and so are perennial flowers started in late summer for the next year.

Many fungi living saprophytically in the upper layers of soil can cause damping-off. *Pythium debaryanum, P. mastophorum* and *Rhizoctonia solani* are probably most common, but other species of these two genera and *Aphanomyces, Botrytis*, *Cylindrocladium, Diplodia, Fusarium, Macrophomina, Helminthosporium, Sclerotium rolfsii, Fusarium equiseti*, and *Phytophthora* may be important on occasion. A synergistic interaction of *Pythium myriotylum, Fusarium solani*, and *Meloidogyne arenaria* causes damping-off of peanut which has been reported in Florida. See under Rots for details. Also, *Caloscypha fulgens* (anamorph state, *Geniculodendron pyriforme*) causes damping-off of spruce seed, *Colletotrichum gloeosporioides* of papaya, *Colletotrichum acutatum* of flowering dogwood and *Fusarium moniliforme* var. *intermedia* of pine.

Damping-off is prevented by starting seed in a sterile medium, such as vermiculite, perlite, or sphagnum moss, or by treating the soil or the seed before planting. Commercial operators treat soil with steam or electricity.

Seed treatment, the coating of seed with a protectant dust, is crop insurance. In some seasons, good stands can be obtained without it, but it scarcely pays

to take a chance. Seed disinfection is used to kill organisms of anthracnose and other specific diseases carried on seed. The damping-off organisms are in the soil, not on the seed, and coating the seed with a chemical is intended to kill or inhibit fungi in the soil immediately surrounding the seed and so provide temporary protection during germination.

DODDER

Dodders are seed plants parasitic on stems and other parts of cultivated or wild plants. They are leafless, orange to yellow twining vines, without chlorophyll and hence incapable of manufacturing their own food. They are called love vine, strangle weed, gold thread, hairweed, devil's hair, devil's ringlet, pull down, clover silk, and hell-bind, the last being most appropriate. There are about 40 species in the United States, causing serious agricultural losses in clovers, alfalfa, and flax, and becoming more and more important in gardens on ornamentals and sometimes vegetables. Dodders belong to the single genus *Cuscuta*, family Cuscutaceae, close to the morning-glory family.

Dodder seed is grayish to reddish brown, resembling small legume seed but roughened with three flattened sides. It germinates as ordinary seed but is synchronized to start a little later than its host seedlings. The parasite is a slender, yellowish, unbranched thread with the growing tip circling around in search of support. When it touches the host it twines like a morning-glory and puts out little suckers, haustoria, into the stem of the victim, after which its original connection with the soil dries up (see Fig. 3.19). Although seedlings can live for a few weeks without a susceptible host, they finally die if a connection is not established. Successful parasites continue to twine and to spread orange tendrils from one plant to the next, often making a tangle of matted orange hairs many feet across, with a black region in the center where plants have died. Such tangles are conspicuous in weeds along roadsides.

In ornamental plantings host plants are not often killed but exhibit stunting and pallor, symptoms of starvation. Minute scales or rudimentary leaves form on the dodder tendrils followed by dense clusters of beautiful white blossoms (sometimes pale pink or yellow), which ripen seed in late summer, with as many as 3000 seed being produced on a single plant.

Cuscuta spp. Much of the dodder infesting ornamentals is not readily identified as to species, but it is widespread on a great many shrubs, perennials and annuals. It is found very commonly on chrysanthemum, also strangling

Figure 3.19 Dodder on Oleander

any other plant in the vicinity. Many hours may be spent cleaning up ivy and trumpet-vine, petunias and asters. Dodder is reported on camellias in the South. It is even a pest of house plants, if field soil has been used for the potting mixture. Dodder has, however, one virtue for plant pathologists. It is used as a bridge between plants to carry viruses and MLOs in testing their host range.

Cuscuta americana on citrus. **C. californica** on beet.

Cuscuta coryli. **Hazel Dodder**. **C. epithymum**. **Clover Dodder** on legumes.

Cuscuta exaltata on redbud, ilex, and sumac.

Cuscuta gronovii. **Common Dodder** on buttonbush, cucumber, raspberry, members of the potato family, and many garden ornamentals, including hedge plants.

Cuscuta indecora. **Bigseed Alfalfa Dodder** on alfalfa from Colorado westward, also on sweet pea and tomato.

Cuscuta paradoxa on rose, Texas and Florida.

Cuscuta pentagona (*C. arvensis*). **Field Dodder**, widely distributed, most common and serious east of Mississippi on many cultivated and wild herbaceous plants.

Cuscuta planifera. **Littleseed Alfalfa Dodder**, on some legumes in the West.

Control. Avoid dodder-infested seed. Commercial seed containing one or more dodder seed per 5-gram sample is prohibited entry into the United States. Many states have laws regulating sale of infested seed, but it may still be included inadvertently in a seed packet. If any contamination with rough, flat-sided seed is found, do not use any of the lot. Commercial dealers sometimes clean infested seed by screening or treating with an iron powder, which sticks to the rough dodder seed so it can be drawn out by magnets.

Before breaking new ground for a garden on native sod, examine it carefully. If dodder is found, burn over the area, then hoe lightly but repeatedly for several weeks to allow buried seed to germinate and die. When dodder is present on cultivated plants, the only thing to do is to remove and burn infested parts before seed is formed. Pulling off the orange tendrils is not sufficient. All parts of the plant attacked must be cut off and burned, for even a small fraction of a tendril left twined around a stem will start growing again.

A fungus, *Colletotrichum destructivum*, has been found to parasitize dodder and offers a slight possibility of biological control.

DOWNY MILDEWS

Downy mildews, sometimes called false mildews, are Oomycetes, in the order Peronosporales and all in the family Peronosporaceae except *Phytophthora* in the Pythiaceae. They form mycelium in higher plants and produce sporangiophores that protrude through stomata in great numbers, their sporangia making white, gray, or violet patches on the leaves. The downy effect distinguishes these mildews from the true or powdery mildews that form white felty or powdery patches.

The sporangiophores are often branched; they bear a single sporangium at the tip of each branch simultaneously, or successively in *Phytophthora*. Sporangia germinate by swarm spores or with a germ tube as a conidium. An oospore, resting spores with external ridges or knobs, is formed in an oogonium, large globular multinucleate female cell, after it is fertilized by the antheridium, a smaller male cell. The oospores are set free by weathering and decay of host parts.

Basidiophora

Oomycetes, Peronosporales

Sporangiophore a single trunk with a swollen apex from which short branches grow out, each bearing a nearly globose sporangium; germination by swarm spores; oospore wall not confluent with that of oogonium. Mycelium is intercellular, haustoria small, knoblike (Fig. 3.20).

Basidiophora entospora. Downy Mildew of aster, China aster, goldenrod, and erigeron. Aster losses are reported by commercial growers in the South, but apparently this is not an important garden problem.

Bremia

Oomycetes, Peronosporales

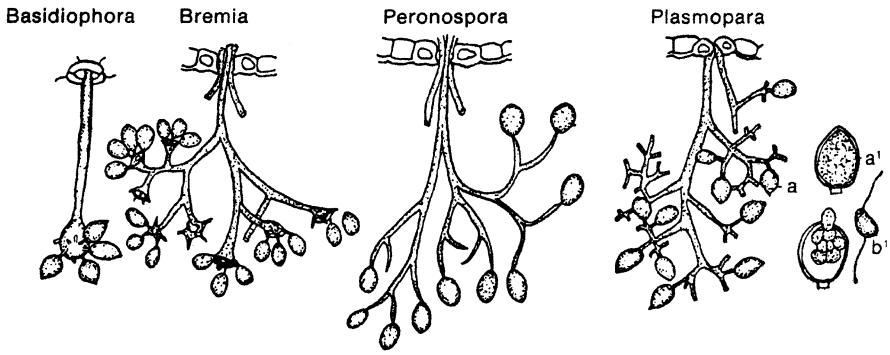

Figure 3.20 Downy Mildews Fruiting from Stomata on Underside of Leaves. *Basidiophora*, sporangiophoore with swollen apex; *Bremia*, sporangiophore tip enlarged to a disc, dichotomous branching; *Peronospora*, sporangia on sharply pointed terminal branches; Plasmopara, on obtuse tips; **a** and **a**^{1}, sporangium; **b**^{1}, zoospore

Dichotomous branching of sporangiophores; tips enlarged into discs bordered with sterigmata bearing sporangia; swarm spores rare; germination usually by a germ tube protruded through an apical papilla (Fig. 3.20).

Bremia lactucae. **Downy Mildew** of lettuce and other composites, endive, cornflower, centaurea, celtuce, escarole, romaine, and various weeds. First noticed around Boston in 1875, the disease is serious in greenhouses and in states where outdoor winter crops are grown. Light green or yellowish areas on upper surface of leaves are matched by downy patches on the under surface. Affected portions turn brown, and leaves die, the older ones first. Entrance is through stomata. The disease is worse in damp, foggy, cool weather (43° to 53°F).

Control. The pathogen has numerous physiological races so that lettuce varieties like Imperial 44 and Great Lakes that are resistant in some localities may not be so in others. Avoid excessive irrigation; eliminate crop residue and weeds.

Peronospora

Oomycetes, Peronosporales

Mycelium intercellular; haustoria in a few species short and knoblike, but in most filamentous and more or less branched. Sporangiophore with erect trunk two to ten times dichotomously branched, with branches somewhat reflexed and terminal branches sharp-pointed; sporangia colored, lacking an apical papilla, germinating from an indeterminate

point on the side. Oospores smooth or variously marked, germinating by germ tubes (see Fig. 3.20).

Peronosclerospora sorghi (formerly *Peronospora sorghi*). Downy mildew, on sweet corn.

Peronospora antirrhini. **Snapdragon Downy Mildew**, reported from California, Oregon, Oklahoma, Pennsylvania, and Maryland.

Peronospora arborescens. **Downy Mildew** of prickly-poppy on leaves, buds, and capsules. Yellow or light brown blotches on upper leaf surface turn dark, with light gray mold on the underside. The fungus winters in old plant debris in soil. Remove and burn infected plants. Use clean seed.

Peronospora arthuri. **Downy Mildew** of godetia, clarkia, gaura, and evening primrose.

Peronospora destructor. **Onion Dowy Mildew**, **Blight**, general on onion, shallot, Vidalia sweet onion, and garlic. One of the more serious diseases of onion, reported in the United States in 1884. All varieties are susceptible, but red onions have some resistance. Reduction in yield may be as high as 75%. The first sign of onion mildew is the production of conidiophores with a purplish tinge a short distance back from tips of older leaves. Leaves turn yellow, wither, and break over; seedstalks may be infected. Onion mildew is sporadic, abundant in years of heavy rainfall. Spores, produced in great numbers in rain or when plants are wet with dew, lose vitality quickly when exposed to sun. Low temperature, optimum 50°F, favors infection. The fungus winters as mycelium in bulbs, in overwintering plants in mild areas, or as oospores in soil. Perennial onions in home gardens are considered an important source of primary inoculum, but oospores have been known to survive 25 years in soil.

Control. Calred is a resistant variety adapted to California. More onion seed is being produced in Idaho, where dry summers preclude mildew.

Peronospora dianthicola. **Carnation Downy Mildew**, common in California on seedlings. Leaves turn pale, curl downward; terminal growth is checked, and plants may die. There is a white growth on lower leaf surfaces.

Peronospora effusa. **Spinach Downy Mildew**, **Chard Blue Mold**, found wherever spinach and swiss chard are grown, absent some seasons, nearly destroying the crop in others. Large pale yellow spots grow together to cover all or part of the leaf; lower leaves are infected first, and then the blight is scattered through the plant. Gray to violet mold forms on underside of leaves;

sometimes the whole plant decays and dries. Initial infection comes from oospores in the soil; it requires humidity above 85% and a mean temperature between 45° and 65°F for a week. Secondary infection is from conidia. The fungus is an obligate parasite and does not live over on hosts other than spinach.

Control. Plant on well-drained, fertile ground; do not crowd; if overhead irrigation is used, water early on sunny days; practice a 2- to 3-year crop rotation. Resistant varieties such as Califlay and Texas Early Hybrid 7 are being introduced.

Peronospora farinosa (formerly *Peronospora schactii*). **Beet Downy Mildew**, on beet, sugar beet, and swiss chard. Inner leaves and seedstalks are stunted and killed, covered with violet down. The disease appears on the Pacific Coast during the fall rainy season. Oospores can survive in the soil several years.

Peronospora fragariae. **Strawberry Downy Mildew**.

Peronospora grisea, on veronica, a grayish mildew on underside of leaves.

Peronospora manshurica. **Soybean Downy Mildew**, general. Yellow-green foliage spots turn brown, with a grayish mold underneath; there may be premature defoliation. The pathogen winters as mycelium in seed and oospores in soil. There are at least three races.

Peronospora myosotidis. **Forget-Me-Not Downy Mildew**, also on lappula. Pale spots on upper surface of leaves, with downy growth underneath.

Peronospora oxybaphi, on sand verbena and four-o'clock.

Peronospora parasitica, on garden cress; **P. leptosperma**, on artemisia; **P. linariae**, on linaria; **P. lophanthi**, on agastache.

Peronospora parasitica. **Downy Mildew** of crucifers, general on cabbage, Chinese cabbage, broccoli, cauliflower, horseradish, radish, turnip, cress, peppergrass, also on sweet alyssum, arabis, arugula, stock, and hesperis. Chief damage is to cabbage seedlings or plants grown for seed. Leaf lesions are light green, then yellow, with downy mold on both sides of the leaf in the widening yellow zone but not in the dead, shrunken, gray or tan central portion. Secondary fungi often cover dead parts with a black sooty mold. Fleshy roots of turnips and radishes may be discolored internally. Warm days and cool nights favor the disease. The pathogen lives between crops in perennial plants or winter annuals. There are several strains of *P. parasitica*; one, often reported as *P. matthiolae*, blights stock in greenhouse and nursery. Leaves wilt; tender stems and flower parts are stunted and dwarfed.

Control. Avoid crowding plants; keep foliage dry. Spray cabbage seedlings; repeat two or three times a week until plants are set in field. Treat heading cabbage every 6 or 7 days beginning 1 to 3 weeks before harvest.

Peronospora pisi. **Pea Downy Mildew**. Water-soaked tissue and white growth appear on any aerial plant part. The mycelium winters in vetch stems, fruiting there in spring, and spores are disseminated back to peas. The disease is not important enough for control measures.

Peronospora potentillae. **Downy Mildew** of agrimony and mock strawberry.

Peronospora radii. **Downy Mildew** of Marguerite daisy, *Argyranthemum frutescens* (formerly *Chrysanthemum frutescens*).

Peronospora rubi. **Downy Mildew** of blackberry, dewberry, and black raspberry.

Peronospora rumicis. **Rhubard Downy Mildew**. A European disease reported from California on garden rhubarb. Fungus winters in rootstalks and grows up into new leaves.

Peronospora schactii (see *Peronospora farinosa*). **Beet Downy Mildew**, on beet, sugar beet, and swiss chard.

Peronospora sorghi (see *Peronosclerospora sorghi*). Downy mildew, on sweet corn.

Peronospora sparsa. **Rose Downy Mildew**, chiefly on roses under glass, rarely outdoors. Young foliage is spotted, leaves drop; flowers are delayed or unmarketable. Abundant spores are produced on undersurface of leaves. To control, keep humidity below 85% and daytime temperature relatively high.

Peronospora statices. **Downy Mildew** on statice.

Peronospora tabacina. **Blue Mold** of tobacco, **Downy Mildew**; also on eggplant, pepper, and tomato. This is a seedling disease that can be controlled by sprays on eggplant and pepper; it is unimportant on tomato.

Peronospora trifoliorum. **Downy Mildew** of lupine, and alfalfa.

Phytophthora

► Blights.

Phytophthora phaseoli. **Downy Mildew** of lima bean, most important in Middle and North Atlantic states, in periods of cool nights, heavy dews, and fairly warm days. Some seasons it takes 50 to 90% of the crop; in other

years it is of little consequence. The white downy mold is conspicuous on the pod, either in patches or covering it completely. The fungus grows through the pod wall into the bean, then the pod dries, turns black. On leaves the white mycelial weft appears sparingly, but veins are often twisted, purplish, or otherwise distorted. Young shoots and flowers are also attacked, bees and other insects carrying spores from diseased to healthy blossoms. The fungus fruits abundantly on pods, stems, and leaves; spores are splashed by rain.
Control. Use seed grown in the West where mildew is not present; plan a 2- to 3-year rotation. Copper dusts are satisfactory.

Plasmopara

Oomycetes, Peronosporales

Sporangiophores with monopodial branches, with obtuse tips, arising more or less at right angles; haustoria unbranched and knoblike; sporangia (conidia) small, hyaline, papillate, germinating sometimes by germ tubes but usually by swarm spores; oospores yellowish brown, outer wall wrinkled, sometimes reticulate, oogonial wall persistent but not fused with oospore wall (see Fig. 3.20).

Plasmopara acalyphae. Acalypha Downy Mildew.
Plasmopara geranii on geranium. **P. gonolobi** on gonolobus.
Plasmopara halstedii. Downy Mildew of bur-marigold, centaurea, erigeron, eupatorium, gnaphalium, goldenrod, hymenopappus, Jerusalem artichoke, ratibida, rudbeckia, senecio, silphium, verbesina, and vernonia. Zoospores germinate in soil moisture and invade seedlings via root hairs; mycelium moving up into stem and leaves causes early wilting and death. Older plants may not die but exhibit a light yellow mottling. Sporangiophores project through stomata on underside of leaves. The fungus winters in seed and as oospores in soil.
Plasmopara crustosa (formerly *Plasmopara nivea*). Downy Mildew of carrot, parsley, parsnip, and chervil. Yellow spots on upper surface of foliage and white mycelial wefts on under surface turn dark brown with age. The disease is relatively infrequent, important when plants are so crowded they cannot dry off quickly after rain or heavy dew. Control by spacing rows properly.
Plasmopara nivea (see *Plasmopara crustosa*). Downy Mildew of carrot, parsley, parsnip, and chervil.

Plasmopara pygmaea, on anemone, and hepatica. Fine white mildew covers underside of leaves; plants are distorted, stems aborted.

Plasmopara viburni. Viburnum Downy Mildew.

Plasmopara viticola. Grape Downy Mildew, general on grape, also on Virginia Creeper and Boston ivy. This is a native disease, endemic in eastern United States, first observed in 1834 on wild grapes. It appeared in France after 1870, imported with American stock resistant to the Phylloxera aphid, and in a few years had become as ruinous to the wine industry of Europe as the potato blight had been to Ireland. The efficacy of bordeaux was first discovered in connection with this mildew.

In this country downy mildew is most destructive on European varieties of grape. Pale yellow spots, varying in form but often nearly circular and somewhat transparent, appear on upper leaf surfaces, and a conspicuous white coating appears on lower surfaces. The spots turn brown with age; in dry weather the downy growth is scanty. Young canes, leafstocks, and tendrils may be infected; flowers may blight or rot; young fruits stop growing, turn dark, and dry with a copious grayish growth. Older fruits have a brown rot but lack the mildew effect. Fruits from diseased vines have less juice; bunches are very poorly filled.

Initial infection comes from a swarm spore stopping on the lower side of a leaf, putting out a germ tube and entering through a stoma. In 5 to 20 days the mycelium has spread through the leaf between cells, obtaining food through thin-walled, globular haustoria. The hyphae mass in compact cushions just beneath the stomata; under humid conditions a few grow out through the openings and develop into branched conidiophores (sporangiophores). Each has three to six main branches, and they branch again. The terminal branches end in two to four short, slender sterigmata, each of which produces a single multinucleate spore. With moisture, each nucleus with adjacent protoplasm is organized into a swarm spore, motile with two cilia. They swim around for a while, then settle down, absorb their cilia, and put out a germ tube. If they happen to be on the upper side of a leaf, nothing happens; if on the lower surface, the germ tube may reach a stoma and start an infection.

Toward the end of the growing season thick-walled resting spores, oospores, are produced in intercellular spaces of the infected leaves. These are set free in spring by disintegration of host tissue, are rain-splashed to other vines, and germinate by production of a short, unbranched hypha bearing a single large sporangium, to start the cycle anew.

Control. Copper sprays are effective. Apply bordeaux mixture immediately before and just after blooming; repeat 7 to 10 days later and possibly when fruit is half grown. Destroy fallen leaves by burning.

Pseudoperonospora

Oomycetes, Peronosporales

Like *Plasmopara* but with branches of sporangiophores forming more or less acute angles; tips more acute.

Pseudoperonospora celtidis. Downy Mildew of hackberry.

Pseudoperonospora cubensis. Downy Mildew of cucurbits, destructive to cucumber, muskmelon, and watermelon, particularly along the Atlantic seaboard and the Gulf Coast, occasional on gourd, pumpkin, and squash. The disease was first noted in 1889 in New Jersey, and in 1896 destroyed most of the cucumbers on Long Island. Irregular yellow spots appear on upper leaf surfaces, often on leaves nearest the center of the hill. The lesion is brown on the opposite side, covered with a purple growth in rain or dew. The whole leaf may wither and die, with the fruit dwarfed to nubbins and of poor flavor. The fungus does not live in the soil and is not prevalent in the North until July or August. It winters in greenhouses or comes up from the South by degrees. Sporangia are spread by wind and cucumber beetles. The disease is favored by high humidity, but temperatures need not be as cool as for other downy mildews.

Control. Resistant cucumbers are of rather poor quality. Cantaloupe varieties Texas Resistant No. 1 and Georgia 47 combine resistance to aphids with resistance to downy mildew.

Sclerospora

Oomycetes, Peronosporales

Oospore wall confluent with that of oogonium; sporangiophore typically stout with heavy branches clustered at apex; mycelium intercellular, with small, knoblike, unbranched haustoria; germination by germ tube or swarmspores. Common in moist tropic regions on corn, millet, sorghum, and sugar cane.

Sclerospora farlowii. **Downy Mildew** of Bermuda grass, in the Southwest. Short, black, dead areas prune off tips of leaves without serious damage to grass. Tissues are filled with thick-walled, hard oospores.

Sclerospora graminicola on cereals.

Sclerophthora macrospora (formerly *Sclerospor*a *macrospora*). **Downy Mildew** of oats, crazy top of corn, wheat, barley, St. Augustinegsrass, Kentucky bluegrass and wild grasses. Plants bunch owing to shortening of internodes.

FAIRY RINGS

Several species of mushrooms growing in circles in lawns and golf greens cause a condition known as fairy ring, rather common when the soil is quite moist and contains a superabundance of organic matter. Less commonly, some of these mushrooms are responsible for a poor condition of other herbaceous plants and of roses. The chief symptom in turf is the appearance of continuous or interrupted bands of darker green, due to the fungus mycelium breaking down organic matter into products easily assimilated by grass roots. Following the zone of stimulated growth there may be a zone of dying grass due to temporary exhaustion of nutrients, or to toxic substances from the mushroom mycelium, or because a layer has developed that is rather impervious to water. The green rings are more conspicuous on underfertilized lawns, and their presence can sometimes be masked by adequate fertilization. Breaking off the mushrooms, possibly spiking the sod, is all the control ordinarily recommended.

The following species are merely representative of the Basidiomycetes found in fairy rings. They are in the order Agaricales, family Agaricaceae.

Cyathus stercoreus (**Bird's Nest Fungus**). Fairy Ring on turf.

Lepiota morgani. On turf and also in rose greenhouses, causing poor growth. The caps are 2 to 12 inches across, white with scattered brown scales; flesh white; gills green when mature, spores green turning yellow, stem bulbous at base with a large ring (annulus). Poisonous, though other members of this genus, also causing fairy rings, are edible.

Marasmius oreades. Cap 2 inches or less, convex to plane, thin, tough, withering but not decaying; gills free from stem; spores white. Edible.

Psalliota (*Agaricus*) **campestris**. Cap 1 1/2 to 3 inches; white, silky, nearly flat; flesh white to pinkish; gills pink, then brown; spores brownish purple; stem white, with a ring when young. Edible.

Other Basidiomycetes found on lawns in moist weather include puffballs, which are very good eating when white and firm inside, and bird's nest fungi, which are tiny cups filled with "seed," resembling a nest of eggs.

Trechispora

Basidiomycetes, Aphyllophorales

Trechispora alnicola. Blight, Fairy Ring of Kentucky bluegrass.

FRUIT SPOTS

Many fruit blemishes are symptoms of rot diseases and are treated under Rots; others are due to physiological disturbances; a few others, limited to fruits and known primarily as fruit spots or specks, are included here.

Aureobasidium

Deuteromycetes

Yeast-like growth characteristics.

Aureobasidium pullulans. **Fruit Russet** on apple.

Cribropeltis

Deuteromycetes, Coelomycetes

Brown mycellium, branches profusely; black, irregularly circular pycnidia; simple, hyaline, clavate conidiophores; pale, oblong, straight or slightly curved conidia.

Cribropeltis citrullina. **Fly Speck** of watermelon fruits.

Zygophiala

► Blotches.

Zygophiala jamaicensis (*Schizothyrium pomi*). **Fly Speck** on apple.

Helminthosporium

► Blights.

Helminthosporium papulosum. **Black Pox** on apples and pears in eastern states. Fruit spots are small, sunken, dark, scattered in profusion over the surface. Blackish papules on bark are followed by a pitted or scaly condition. Spray with sulfur (except at high temperatures).

Microthyriella

Ascomycetes, Hemisphaeriales

Vegetative mycelium lacking; stromata with radial structure appearing as black superficial dots on leaves or stems.

Microthyriella rubi (see *Schizothyrium pevexiguum*). **Fly Speck** of pome fruits, general on apple, also on pear, quince, citrus fruits, banana, Japanese persimmon, plum, blackberry, raspberry, and grape.

Schizothyrium pevexiguum (formerly *Microthyriella rubi*). **Fly Speck** of pome fruits, general on apple, also on pear, quince, citrus fruits, banana, Japanese persimmon, plum, blackberry, raspberry, and grape. The pathogen has long been recorded as *Leptothyrium pomi*, but this is apparently a misconception. The anamorph state is *Zygophiala jamaicensis*, originally isolated from banana and recently reported as causing a greasy blotch of carnations. Flyspeck is often associated with sooty blotch on apples, but the two diseases are distinct. Flyspeck looks like its name, groups of 6 to 50 very small, slightly elevated, superficial black dots connected with very fine threads. Spots may extend entirely around blackberry canes and shoots.

Mycosphaerella

► Anthracnose.

Mycosphaerella pomi. **Brooks Fruit Spot**, **Phoma Fruit Spot**. Quince Blotch, of apple and quince, most prevalent in northeastern states. Spots appear on fruits in July or early August, deeper red on the colored face of apples, darker green on the lighter surface. They are irregular, slightly sunken, more abundant near the calyx end of the fruit, usually with centers flecked with black. The symptoms on quince are more of a blotch than a definite spot.

Rhodotorula

Rodotorula glutinis. **Fruit Russet** on apple.

GALLS

Galls are local swellings, hyperplastic enlargements of plant tissue due to stimulation from insects, bacteria, fungi, viruses, and occasionally physiological factors. Crown gall, a common and serious problem, is discussed under Bacterial Diseases. Cedar galls are treated under Rusts. See Black Knot for hypertrophy of plum branches.

Exobasidium

Basidiomycetes, Exobasidiales

Mycelium intercellular with branched haustoria entering host cells; basidia extend above the layer of epidermal cells much like the layer of asci in *Taphrina*; each basidium bears two to eight basidiospores. Species cause marked hypertrophy in the Ericaceae.

Exobasidium vaccinii. Leaf Gall, widespread on flame azalea.

Exobasidium burtii. Leaf Gall, Yellow Leaf Spot on azalea and rhododendron.

Exobasidium camelliae. Camellia Leaf Gall on camellia in the Southeast, more common on sasanqua than on japonica. Symptoms are a striking enlargement and thickening of leaves and a thickening of stems of new shoots. Diseased leaves are four or more times as wide and long as normal leaves, very thick and succulent. Color of the upper surface is nearly normal, but the underside is white with a thin membrane that cracks and peels back in strips or patches exposing the spore-bearing layer. There is seldom more than one diseased shoot on a stem, and not many on the whole bush; so the disease does not cause serious damage.

Control. Handpicking of affected parts, searching carefully for diseased leaves at base of new growth, removing them before spores are formed, keeps sporadic infection at a minimum. Spraying with a low-lime bordeaux may be effective but is seldom necessary.

Exobasidium oxycocci. **Cranberry Rose Bloom**, **Shoot Hypertrophy** on cranberry, and manzanita. The disease appears in cranberry bogs soon after water is removed in spring. Bud infection results in abnormal lateral shoots with enlarged, swollen, pink or light rose distorted leaves that somewhat resemble flowers. Excessive water supply promotes the disease. Remove water early in spring. If necessary, spray with bordeaux mixture.

Exobasidium rhododendri. **Rhododendron Leaf Gall**. Large vesicular galls, especially on *Rhododendron catawbiense* and *R. maximum*.

Exobasidium symploci. **Bud Gall** on sweetleaf.

Exobasidium uvae-ursi. **Shoot Hypertrophy** of bearberry.

Exobasidium vaccinii. **Azalea Leaf Gall**, **Red Leaf Spot**, **Shoot Hypertrophy** of andromeda, arbutus (*A. menziesii*), bearberry, blueberry (fruit green spot), box sandmyrtle, chamaedaphne, cranberry, farkleberry, huckleberry, ledum, leucothoë, manzanita, and rhododendron. On azaleas and other ornamentals the galls are bladder-shaped enlargements of all or part of a leaf, sometimes a flower bud (see Fig. 3.21). They are white or pink, soft and succulent when young, brown and hard with age. This is seldom a serious disease but in wet seasons, particularly in the South, and in shaded gardens, the number of galls may become rather alarming. On cranberries and blueberries the gall is a small, round, red blister in the leaf, with spores packed in a dense layer on the underside. The fungus is systemic in blueberries, fruiting on the leaves in June and July.

Control. Handpick and destroy galls as they appear. Spraying is seldom required for cranberries and other fruits.

Exobasidium vaccinii-uliginosi. **Shoot and Leaf Gall**, **Witches' Broom** of rhododendron, manzanita, and mountain heath. An excessive number of twigs is formed on infected branches. Leaves are yellowish white covered with a dense mealy fungus growth. The mycelium penetrates the whole plant so that it is wiser to remove the shrub than to attempt remedial measures.

Fusarium

► Rots.

Fusarium decemcellulare (Teleomorph, *Nectria rigidiuscula*). **Gall** on midge.

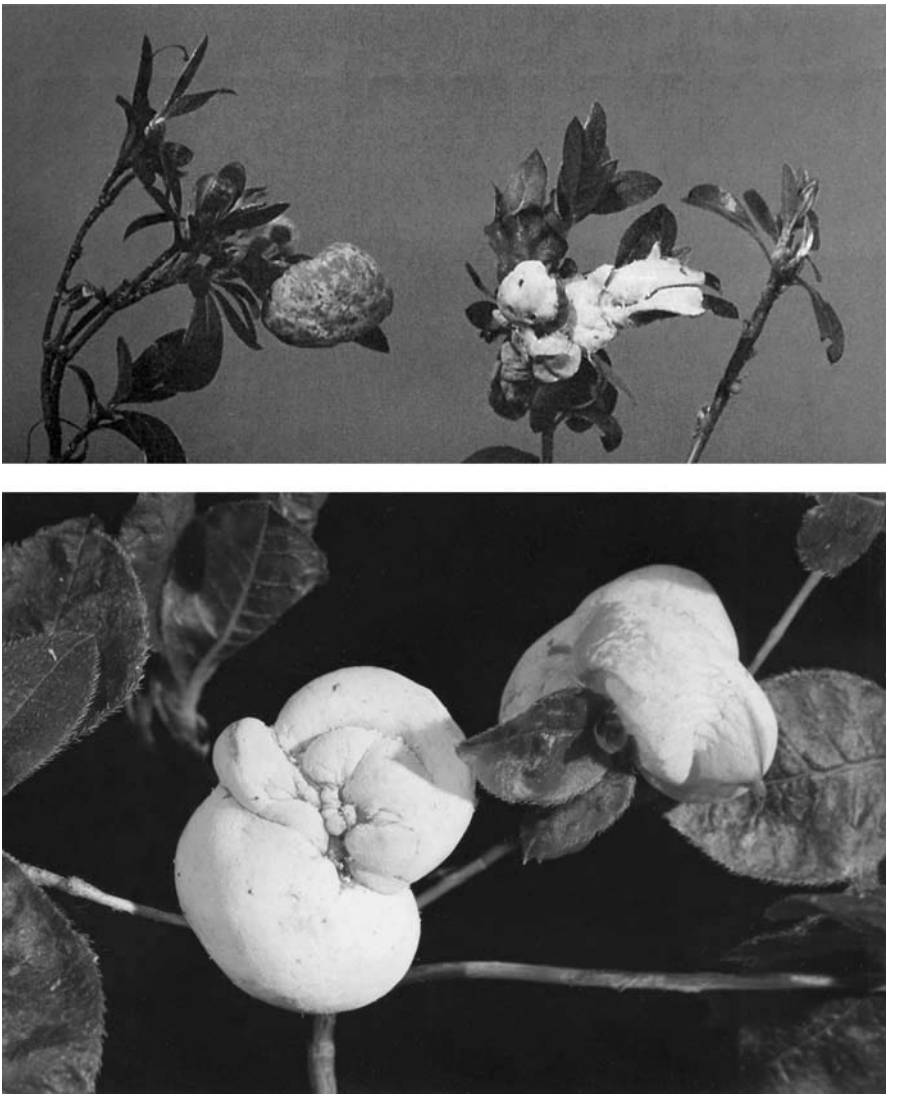

Figure 3.21 Azalea Leaf Gall

Kutilakesa

Deuteromycetes, Hyphomycetes

Sporodochia erumpent, pale olive-green, cushion-shaped; similar to Kutilakesopsis but differs by having larger two-celled conidia; teleomorph state is *Nectriella*.

Kutilakesa pironii. **Stem and Leaf Gall**, **Cankers** on croton, zebra plant, and *Clorodendron*.

Nocardia

Actinomycetales

Related to bacteria with mycelial filaments breaking up into rod forms.

Nocardia vaccinii. **Blueberry Bud-Proliferating Gall**, first observed in Maryland in 1944, described as a new species in 1952. Galls, similar to crown gall, are formed at the soil line. Abnormal buds abort at an early stage or grow into weak shoots, 1 to 6 inches high, forming a witches' broom effect.

Phoma, Phomopsis

► Blights.

Phoma sp. or **Phomopsis** sp. **Stem Gall** on winter jasmine, privet, forsythia, and rose, at scattered locations. Both pathogens have been reported causing roundish, rather rough stem enlargements on ornamentals. It has not been determined whether more than one fungus is involved.

Plasmopara

► Downy Mildew.

Plasmopara halstedii. **Basal Gall** on sunflower.

Protomyces

Archiascomycetes, Taphrinales

Protomyces gravidus. **Stem gall** on ragweed.
Protomyces macrosporus. **Leaf gall** on hedge parsley (*Torilis* sp.).

Sphaeropsis

► Cankers.

Sphaeropsis tumefaciens. **Canker** and **Gall** on *Carissa*.

Synchytrium

Chytridiomycetes, Chytridiales

Mycelium lacking; thallus converted into a soros with a membrane, at maturity functioning in entirety as a resting sporangium or divided to form many sporangia in a common membrane; zoospores with one cillum at posterior end. Various species cause excrescences on leaves and fruit; potato wart.

Synchytrium anemones. **Leaf Gall**, **Flower Spot** of anemone and thalictrum. Flowers are spotted, distorted, dwarfed, and may fall. Red spots are formed on leaves and stems.

Synchytrium aureum. **Red Leaf Gall**, **False Rust** on many plants, 130 species in widely separated genera, including calypha, artemisia, clintonia, delphinium, geum, golden-glow, marsh-marigold, and viola. Pick off and burn affected parts.

Synchytrium endobioticum. **Potato Wart**, **Black Wart** of potatoes, a warty hypertrophy of tubers. A European disease wart was found in 1918 in backyard gardens in mining towns of Pennsylvania, Maryland, and West Virginia. Diseased tubers had apparently been brought in by immigrants. A strict quarantine was placed on infested districts, and there has been no spread to commercial potato fields. The disease shows as prominent outgrowths or warts originating in the eyes, varying from the size of a pea to that of the tuber itself. Numerous yellow sporangia are released into the soil by decay of the malformed tissue. The disease, which may affect other species of *Solanum*, is spread by contaminated soil or infected tubers. Buds and adventitious shoots of tomato are infected below the soil line.

Control. By 1953 potato wart had been eradicated from more than half of the 1112 infested gardens in Pennsylvania. The plan called for applying copper sulfate the first year, keeping the land clean and cultivated, applying lime the next year, growing vegetables the third year, and going back to potatoes the fourth year to test results.

Synchytrium vaccinii. **Red Leaf Gall** on cranberry, azalea, chamaedaphne, gaultheria, and ledum, from New Jersey northward. On cranberry the disease appears just before blossoms open. Buds, flowers and young leaves are covered with small, red, somewhat globular galls about the size of birdshot; affected shoots bear no fruit. The disease is erratic in appearance but is most frequent in bogs that have excessive or uneven water supply.

Synchytrium sp. **Stem Gall** on castor bean, in Texas. Small red galls on stems, petioles, and leaves of seedlings.

LEAF BLISTER AND LEAF CURL DISEASES

A single genus, *Taphrina*, is responsible for most of the hyperplastic (overgrowth) deformities known as leaf blister, leaf curl, or, occasionally, as pockets.

Taphrina

Archiascomycetes, Taphrinales

Parasitic on vascular plants, causing hypertrophy. Asci in a single palisade layer, not formed in a fruiting body; hyphal cells become thin-walled chlamydospores; on germination the inner spore protrudes from the host and is cut off by a septum to form an eight-spored ascus, which may become many-spored by budding or the ascospores.

Taphrina spp. **Maple Leaf Blister**. Leaves after expanding in spring show dark spots, shrivel, and fall. The disease may be locally epidemic; it is more common in shaded locations.

Taphrina aceris. **Western Maple Leaf Blister**.

Taphrina aesculi. **Leaf Blister** of California buckeye; yellow turning to dull red; witches' brooms formed.

Taphrina australis. **American Hornbean Leaf Curl**.

Taphrina caerulescens. **Oak Leaf Blister** on various oak species, with red oak particularly susceptible but often defoliating and sometimes killing water, willow, laurel, and live oaks in the South. Blisters start on young partially grown leaves as gray depressed areas on the undersurface, convex and yellow on the upper surface. Individual blisters are 1/4 to 1/2 inch across but often become confluent, causing the leaf to curl. Ascospores are borne on the surface of the blistered area. The disease is most serious in a cool wet spring. *Control*. A single dormant eradicant spray, before the buds swell, controls the disease; later sprays are ineffective.

Taphrina carnea. **Birch Red Leaf Blister**.

Taphrina castanopsidis. **California Chinquapin Leaf Blister**.

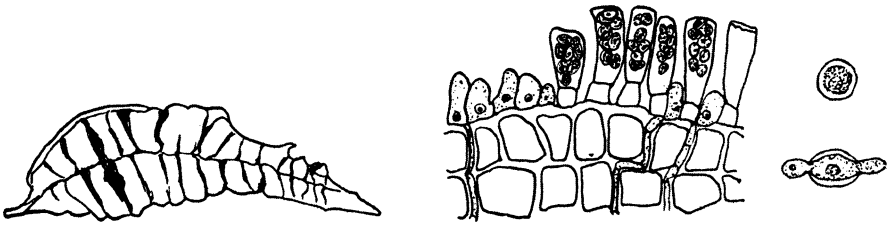

Figure 3.22 Peach Leaf Curl; deformed leaf; palisade layer of asci formed on curled portion; germinating spore

Taphrina communis. **Plum Pockets**, common on American plums; **T. pruni**, on European species, not in United States; **T. prunisubcordata**, in western United States. Leaves, shoots and fruits become puffy and enlarged into reddish or white swollen bladders. Fruits are sometimes ten times the size of normal plums. Most garden plums are of foreign origin and not susceptible to the American species of *Taphrina*. Bordeaux mixture applied in spring before flower buds open gives satisfactory control.

Taphrina coryli. **Hazelnut Leaf Blister**.

Taphrina deformans. **Peach Leaf Curl**, general on peach, also on nectarine and almond but not on apricot. This is an old disease, known in the United States for well over a century but not quite so important since 1900, when a control was worked out. Young leaves are arched and reddened, or paler than normal as they emerge from the bud, then much curled, puckered, and distorted, greatly increased in thickness (Fig. 3.22). Any portion or the entire leaf may be curled, and one or all leaves from a bud. The leaves often look as if a gathering string had been run along the midvein and pulled tight. Leaves may drop, lowering vitality of tree, with partial or total failure to set fruit, and increasing chances of winter injury. Young fruits may be distorted or cracked. Defoliation for several seasons kills tree outright.

The fungus has no summer stage, and the asci are formed not in a fruiting body but in a layer over infected surfaces, giving them a silvery sheen. Before leaves fall, ascospores are discharged from this layer, and land on bark or twigs and bud scales, there to germinate by budding into yeastlike spores, which remain viable over winter, sometimes for 2 years. In spring they are washed by rain to opening leaf buds.

Control. One spray during the dormant season gives effective control. This is best applied just before the buds swell, but can be done any time after leaf fall in autumn when the temperature is above freezing. Applications after the buds swell have little effect.

Taphrina faulliana. Leaf Blister of Christmas fern; **T. filicina**, on sensitive fern; **T. struthiopteridis**, on ostrich fern.
Taphrina flava. Yellow Leaf Blister of gray and paper birches in northeastern states.
Taphrina japonica (*T. macrophylla*). Leaf Curl on red alder. Young leaves are enlarged to several times normal size and curled. They dry up after ascospore discharge, and a new crop of healthy leaves is formed.
Taphrina populina. Leaf Blister, Yellow on poplar.
Taphrina populina. Poplar Yellow Leaf Blister. Conspicuous blisters, small to large, an inch or more in diameter, are brilliant yellow on the concave side when the asci are fully developed; later the color changes to brown.
Taphrina robinsoniana, **T. occidentalis**, **T. alni**. Catkin Hypertrophy of alder. Scales of catkins enlarge and project as reddish curled tongues covered with a white glistening layer. Infection can be reduced with a lime sulfur spray.
Taphrina sacchari. Maple Brown Leaf Blister.
Taphrina ulmi. Elm Leaf Blister. Very small blisters on elm leaves. Dusting nursery trees with sulfur has helped.
Taphrina weisneri. Cherry Witches' Broom, Leaf Curl on wild and cultivated cherries, **T. flavorubra**, on sand cherry; **T. flectans**, on western wild cherry; **T. farlowii**, leaf curl and fruit pockets on eastern wild cherry; **T. confusa**, on chokecherry; **T. thomasii**, witches' broom of cherry-laurel in California.

LEAF SCORCH

According to the dictionary scorching means to heat so as to change color and texture without consuming. Sometimes leaves are literally scorched in summer heat, and sometimes symptoms caused by fungi resemble those of a heat scorch. This section includes some of the latter.

Ceratocystis

► Cankers.

Ceratocystis paradoxa. **Black Scorch**, **Bud Scorch**, **Heart Rot** of coconut, Canary, Washington, and Guadaloupe palms, also causing a pineapple disease in the tropics. The most striking symptom is a black, irregular, necrotic condition of the leaf stalk. The tissues look as if they had been burned, whence the name black scorch. Furled pinnae of leaf fronds show pale yellow spots with broad margins that later converge and turn black; infection spreads rapidly, and in severe cases the heart leaves dry up. The heart rot discolors trunk tissues and rots the pithy material between cells. Infection is through wounds during periods of relatively high humidity, or through roots, or sometimes through uninjured fruit strands, petioles, or pinnae. Palms with vitality lowered, as when the normal crown of leaves has been reduced but the water supply to the leaves is not reduced, are most susceptible.

Control. Destruction of infected parts seems to be the chief control measure. It is easier to bury than to burn palm trunks.

Curvularia

► Blights.

Curvularia sp. **Leaf Scorch** on pecan.

Diplocarpon

► Blackspot.

Diplocarpon earlianum. **Strawberry Leaf Scorch**, general where strawberries are grown but more prevalent in the South. Dark purplish spots about 1/4 inch in diameter are scattered profusely over upper surface of leaves in all stages of development. Later the spots enlarge to scorch wide areas of the leaf, and black fruiting bodies give a "tar spot" appearance. Scorch spots always lack the white centers so characteristic of Mycosphaerella leaf spot on strawberry. Lesions are found on petioles, stolons, and fruit stalks as well as leaves. If the fruit stems are girdled, flowers or young fruits die. Rarely the disease appears on green berries as a superficial red or brown discoloration and flecking. Spores, produced in quantity in acervuli on lesions, are distributed by birds, insects, and pickers on tools and clothing. The fungus winters in old leaves. Teleomorph and anamorph states are both produced in spring, and repeated infections occur throughout the summer in moist weather.

Control. Remove all old leaves when setting plants in spring. Spray with bordeaux mixture at 10-day intervals, starting in January in Louisiana, late February in North Carolina. Fairly resistant varieties include Catskill, Midland, Fairfax, Howard 17, Blakemore, Southland.

Epicoccum

► Leaf Spots.

Epicoccum sp. **Leaf Scorch** on pecan.

Fusarium

► Rots.

Fusarium sp. **Leaf Scorch** on pecan.

Hendersonia

Deuteromycetes; Coelomycetes

Pycnidia dark, separate, globose, ostiolate, immersed then usually erumpent; conidia dark, several-celled, elongate to fusoid; saprophytic or parasitic. **Hendersonia opuntiae**. Scorch, Sunscald, common and serious on prickly pear cactus (*Opuntia*). Segments turn reddish brown and die; centers are grayish brown and cracked.

Pestalotia

► Blights.

Pestalotia sp. Leaf Scorch on pecan.

Pseudopezicula

Ascomycetes, Helotiales

Hyaline, gelatinous apothecia containing paraphyses and 20 - 80 asci; asci contain 4 reniform, binucleate ascospores; five-spored asci rarely observed.

Pseudopezicula tetraspora. Leaf Scorch of grapevines.

Septoria

► Blights.

Septoria azaleae. Azalea Leaf Scorch, Leaf Spot. Small, yellowish, round spots enlarge irregularly, turn reddish brown, with dark brown centers. Leaves fall prematurely; black fruiting bodies are produced in fallen leaves. The disease is most severe in greenhouses in fall and winter and under high humidity.

Stagonospora

Deuteromycetes, Coelomycetes

Pycnidia dark, separate, superficial, or erumpent, globose, ostiolate; conidiophores short; conidia hyaline, typically with three or more cells, cylindrical to elliptical; parasitic or saprophytic.

Stagonospora curtisii. **Narcissus Leaf Scorch**, **Red Blotch** of Amaryllis, **Red Leaf Spot**, **Red Fire Disease**, also on crinum, eucharis, hymenocallis, leucojum, nerine, sternbergia, vallota, and zephyranthes.

Leaf tips of narcissus are blighted for 2 or 3 inches as in frost injury and separated off from healthy basal portions of leaves by a definite margin or yellow area. Spores formed in pycnidia in the dead area furnish inoculum for secondary infection, which consists of lesions in lower portions of leaves, minute water-soaked or yellowish spots becoming raised, scabby, and reddish brown. Flower stalks may be spotted; brown spots appear on petals. Bulbs suffer loss in weight due to killing of foliage a month or two before normal dying down. All types may be infected but the most susceptible varieties are in the Leedsii and Polyanthus groups. The fungus was described on narcissus in 1878 but was not considered a threat to it, nor was it known to be connected with amaryllis red blotch before 1929.

On amaryllis or hippeastrum red spots are formed on leaves, flower stems, and petals. On foliage the spots are bright red to purplish, small at first but often increasing to 2 inches. Leaf or flower stalks are bent or deformed at the point of attack. This disease should not be confused with "red disease" caused by mites. The spores are variable in size and number of cells, one to six. They are embedded in a gelatinous matrix and are disseminated in rain. The fungus apparently winters in or on bulbs, infecting new leaves as they grow out in spring.

Control. Treat suspected narcissus bulbs before planting. Control secondary infection in the field with bordeaux mixture. Discard seriously diseased amaryllis bulbs; remove infected leaves and bulb scales; avoid syringing and heavy watering.

LEAF SPOTS

Leaf spots are the most prevalent of plant diseases, so common we seldom notice them, and rightly so, for if we should attempt to control all the miscellaneous leaf spots that appear in a small suburban garden in a single season, we would quickly go mad. A typical leaf spot is a rather definitely delimited necrotic lesion, often with a brown, sometimes white, center and a darker margin. When the spots are so numerous they grow together to form large dead areas, the disease becomes a blight, or perhaps a blotch, or scorch. Certain types of lesions are called anthracnose, spot anthracnose, blackspot. All of these have been segregated out in their different sections. What is left is a very large collection of names.

The genus *Septoria*, for instance, has about 1000 species, *Mycosphaerella* 500, *Cercospora* 400, chiefly identified by the hosts on which they appear. *Cercospora beticola* is so named because it causes a leaf spot of beet, *C. apii* for its celery host. Species recorded in this country as causing a definite disease are listed under their respective hosts. They are not repeated here unless the leaf spot is of some importance or there is some useful information that can be added to the name.

Most leaf spot diseases flourish in wet seasons. A comparative few may be important enough to call for control measures other than general sanitation. Adequate protection usually means several applications of fungicides, and the cost of spraying trees and shrubs must be balanced against the expected damage. Calling in a tree expert with high-pressure apparatus is often an expensive proposition. If the budget is limited, it is more important to have an elm sprayed for elm leaf beetles, which cause defoliation every season, than for elm black spot, which may be serious in only one year out of three or four. When it comes to rose blackspot (no relation to elm black spot), weekly protection with a fungicide is necessary, but to save labor it can be combined with insecticides.

Actinothyrium

Deuteromycetes, Coelomycetes

Pycnidia superficial, globose, with a more or less fimbriate shield; spores filiform, hyaline.

Actinopelte dryina (see *Tubakia dryina*). On oak.
Actinothyrium gloeosporioides (see *Tubakia dryina*). On oak. **Leaf Spot** on sassafras.
Tubakia dryina (formerly *Actinopelte dryina*). On oak. Very small dark spots between veins. Conspicuous in midsummer but not serious.
Tubakia dryina (formerly *Actinothyrium gloeosporioides*). **Leaf Spot** on sassafras.

Alternaria

► Blights.

Alternaria alternata. **Leaf Spot** of *Calathea* spp.
Alternaria alternata (formerly *Alternaria fasciculata*). **Leaf Spot** on rose-acacia and asclepiodora.
Alternaria alternata (formerly *Alternaria tenuis*). **Leaf Spot** of magnolia, hibiscus, clarkia, and many ornamental and other hosts. The fungus is a general saprophyte and an occasional weak parasite. It discolors beet, chard, and spinach seed.
Alternaria angustiovoidea. **Leaf Spot** and **Blight** of leafy spurge.
Alternaria brassicae (with large spores) and **A. brassicicola** (with small spores). **Black Leaf Spot** of crucifers, cabbage, Chinese cabbage, collards, turnip, garden cress, mustard greens, radish, and horseradish; **Head Browning** leaf and pod spot of cauliflower; **Damping-off**, **Wire-stem** of seedlings.
Seedlings are subject to pre- or post-emergence damping-off, with dark brown to black sunken spots on cotyledons, narrow dark spots on stems, followed by wire-stem, a blackening toward the base. Leaf spots are small, circular, yellowish, enlarging in concentric circles with a sooty black color from the spores. In storage the spots unite to form a moldy growth over the entire leaf. On seed pods, spots are purplish at first, later brown; in moist

weather entire pods may be infected. Cauliflower infection is a browning of the head, starting at the margin of an individual flower or cluster. Spores are blown, splashed by tools, spread on feet of men and animals. Seed bears spores externally, mycelium internally. Wounds are not necessary for infection.

Control. Hot water treatment of seed, 122°F for 30 minutes, is fairly effective. Use long rotation for cauliflower, avoiding all other crucifers in intermediate years.

Alternaria brassicicola. **Leaf Spot** on Thlaspi.

Alternaria brassicicola (formerly *Alternaria oleracea*). **Cabbage Leaf Spot**, occasional on crucifers. Has been confused with *A. brassicicola*.

Alternaria catalpae. **Catalpa Leaf Spot**, widespread in rainy seasons. Small, water-soaked spots, up to 1/4 inch, appear over the leaf; they turn brown and sometimes drop out leaving shot holes; there is more or less defoliation. The fungus is sometimes secondary following bacterial infection or midge infestation. Rake up and burn fallen leaves.

Alternaria chrysanthemi (see *Alternaria leucanthemi*). **Leaf Spot** on shasta daisy, and Canada thistle.

Alternaria citri. **Cherry Leaf Spot**, occasional, more often a rot of citrus fruits. ►Rots.

Alternaria fasciculata (see *Alternaria alternata*). **Leaf Spot** on rose-acacia and asclepiodora.

Alternaria leucanthemi (formerly *Alternaria chrysanthemi*). **Leaf Spot** on shasta daisy, and Canada thistle.

Alternaria longipes. **Brown Spot** of tobacco, including ornamental flowering tobacco. Small spots on lower leaves rapidly enlarge and turn brown. The fungus winters on old stalks, which should be removed and burned.

Alternaria oleracea (see *Alternaria brassicicola*). **Cabbage Leaf Spot**, occasional on crucifers.

Alternaria panax. **Leaf Spot** of schefflera, *Dizygotheca*, and *Tupidanthurs*.

Alternaria passiflorae. **Brown Spot** of passion flower. Minute brown leaf spots, enlarging to an inch across are concentrically zoned with various shades of brown. Dark green water-soaked spots on fruit turn brown; the fruit shrivels, but the spots stay firm.

Alternaria polypodii. **Fern Leaf Spot**. Brown, circular to ovate, concentrically zonate spots are formed along margins of fronds. Chains of spores are spread by syringing or air currents. Keep foliage dry; remove and burn diseased leaves.

Alternaria raphani. **Radish Leaf Spot**. Yellow spots with black sporulation, often with centers dropping out. Also occurs on turnip.
Alternaria sonchi. **Leaf Spot** of lettuce, escarole, endive, and chicory.
Alternaria tagetica. **Leaf Spot** of marigold.
Alternaria tenuis (see *Alternaria alternata*). **Leaf Spot** of magnolia, hibiscus, clarkia, and many ornamental and other hosts.
Alternaria tenuissima. **Leaf Spot** on blueberry.
Alternaria tenuissima (formerly *Alternaria tomato*). **Nailhead Spot** of tomato, a leaf, stem, and fruit spot. On leaves and stems the disease is much like early blight (see *A. solani* under Blights) with small dark brown spots with yellow margins. But on fruit the disease is quite different. Very small tan spots, 1/16 to 1/8 inch in diameter, become slightly sunken, with grayish brown centers and darker margins. Spores produced abundantly on fruit and foliage are spread by winds and splashing rain. Treat seed and spray as for early blight. Varieties Marglobe, Pritchard, Glovel, and Break O'Day are quite resistant to nailhead spot. The same fungus causes ghost spot of apple.
Alternaria tomato (see *Alternaria tenuissima*). **Nailhead Spot** of tomato, a leaf, stem, and fruit spot.
Alternaria sp. **Leaf Spot** of schefflera, and umbrella tree.

Amerosporium

Deuteromycetes, Coelomycetes

Pycnidia superficial, discoid to cupulate, hairy; spores one-celled, hyaline.

Amerosporium trichellum (see *Colletotrichum trichellum*). **Leaf Spot** and **Stem Spot** on English ivy.
Colletotrichum trichellum (formerly *Amerosporium trichellum*). **Leaf Spot** and **Stem Spot** on English ivy. In some cases stems are girdled, causing collapse and death.

Annellophora

Deuteromycetes, Hyphomycetes

Conidiophores brown, simple, slender, elongating by successive proliferations through conidial scars; conidia brown, multiseptate, obclavate to fusoid.

Annellophora phoenicis. **Leaf Spot** of date palm.

Aristastoma

Deuteromycetes, Coelomycetes

Pycnidia brown, globose, erumpent, separate, with dark brown setae near ostiole; conodiophores short, simple; conida hyaline, several-celled.

Aristastoma oeconomicum. **Zonate Leaf Spot** of cowpea, kidney bean.
Aristastoma sp. **Leaf Spot** on desert-rose.

Ascochyta

► Blights.

Ascochyta abelmoschi (possibly identical with *A. phaseolorum*). **Leaf Spot**, **Pod Spot**, **Stem Spot** of okra. Dark, small, water-soaked spots slowly enlarge, turn brown, with many large black pycnidia in concentric rings in dead tissue. Young okra pods are severely infected, and the mycelium grows into the seed.
Ascochyta althaeina (see *Phoma exigna*). **Leaf Spot** of hollyhock, rose-mallow.
Ascochyta armoraciae. **Leaf Spot** of horse-radish.
Ascochyta aspidistrae. **Aspidistra Leaf Spot**. Large, irregular pale spots on leaves.
Ascochyta asteris (see *Phoma exigna*). **Leaf Spot** of China aster.
Ascochyta boltshauseri. (see *Stagonosporopsis hortensis*). **Leaf Spot**, **Pod Spot** of beans, on snap, kidney, lima, and scarlet runner beans, reported in Oregon.
Aschochyta. **Leaf Spot** on big bluestem, little bluestem (both species of *Andropogon* and on indiangrass.
Ascochyta cheiranthi. **Leaf and Stem Spot** of wallflower. Grayish spots up to 1/2 inch long, may girdle stems. Leaf spots are circular to elongate, brown with darker brown margins. Dark pycnidia contain hyaline, two-celled spores. Leaves wilt and fall; potted plants may be infected. Keep greenhouse on the dry side.
Ascochyta clematidina. **Clematis Leaf** and **Stem Spot**, widespread. On out-door plants stems are infected near the ground and are often girdled, upper portions dying back. Spores for initial infection probably come from

pycnidia on stumps of old stems. Leaf spots are more common in greenhouses, small, water-soaked, then buff with reddish margins. Remove and destroy infected leaves and stems.

Ascochyta compositarum. Leaf Spot on aster, eupatorium, silphium, and sunflower.

Ascochyta cornicola. Dogwood Leaf Spot.

Ascochyta cypripedii. Cypripedium Leaf Spot, reported on orchid from Wisconsin. Leaf lesions are narrow, brownish, with a dark brown border.

Ascochyta juglandis. Walnut Ring Spot. Very small, round, brown leaf spots between veins, ringed with targetlike ridges. The disease is unimportant in trees sprayed for walnut blight.

Ascochyta lycopersici (**Didymella lycopersici**) (see *Phoma lycopersici*) Leaf Spot, Ascochyta Blight of tomato, eggplant, and potato.

Ascochyta phaseolorum (see *Phoma exigua*). Leaf Spot of snap beans.

Ascochyta pisi. Leaf Spot, Pod Spot of pea. General, but rare in the Northwest. One of three species causing the disease complex known as Ascochyta blight (also see Blights). Foliage spots are circular to irregular, pinhead size to 1/2 inch. Stem lesions, at nodes or base, are brown to purplish black. Brown pycnidia exude spore tendrils in wet weather.

Phoma exigua (formerly *Ascochyta althaeina*). Leaf Spot of hollyhock, rose-mallow.

Phoma exigua (formerly *Ascochyta asteris*). Leaf Spot of China aster. Spray foliage with bordeaux mixture.

Phoma exigua (formerly *Ascochyta phaseolorum*). Leaf Spot of snap beans. Recent isolation and inoculation studies indicate that the Ascochyta leaf blights of hollyhock, okra, pepper, eggplant, and tomato are all caused by strains of the bean pathogen.

Phoma lycopersici (formerly *Ascochyta lycopersici* (*Didymella lycopersici*)). Leaf Spot, Ascochyta Blight of tomato, eggplant, and potato. Brown spots with concentric rings are formed on leaves and stems, sometimes cankers at base of young stems. Black pustules in center of spots discharge spore tendrils in wet weather. The fungus winters in old plant refuse, is a weak parasite, and is ordinarily too unimportant for control measures.

Stagonosporopsis hortensis (formerly *Ascochyta boltschauseri*). Leaf Spot, Pod Spot of beans, on snap, kidney, lima, and scarlet runner beans, reported in Oregon. Spots on leaves and pods are dark to drab, zonate; light to dark brown pycnidia are numerous.

Asteroma

Deuteromycetes, Coelomycetes

Pycnidia globose with a radiate subicle, a compact, crustlike growth of mycelium underneath; without an ostiole; spores hyaline, one-celled.

Asteroma garretianum. **Black Spot** on primrose.
Asteroma solidaginis. **Black Spot**, **Black Scurf** on goldenrod.
Asteroma tenerrimum. **Black Spot** on erythronium.

Asteromella (Stictochlorella)

Deuteromycetes, Coelomycetes

Pycnidia smooth, with ostiole, densely gregarious in asteroma-like spots; spores hyaline, one-celled.

Asteromella lupini. **Leaf Spot** on lupine.

Botrytis

► Blights.

Botrytis fabae. **Chocolate Leaf Spot** on vetch.

Calonectria

See Cylindrocladium under Blights.
Calonectria colhounii. **Leaf Spot** on sentry palm.
Calonectria crotalariae. **Leaf Spot** on sentry palm.
Calonectria theae. **Leaf Spot** on sentry palm.

Cephaleuros

One of the green algae, possessing chlorophyll but not differentiated into root, stem, and leaves; forming motile spores in sporangia.

Cephaleuros virescens. **Algal Spot**, **Red Leaf Spot**, **Green Scurf** in the far South or in greenhouses on acacia, albizzia, ardisia, avocado, bixa,

bischofia, camellia, camphor-tree, cinnamon-tree, citrus, grevillea, guava, jasmine, jujube, loquat, magnolia, mango, pecan, Japanese persimmon, privet, rhododendron, viburnum.

On some hosts this is a disease of twigs and branches, which may be girdled and stunted, covered with reddish brown hairlike fruiting bodies. On magnolia leaves velvety, reddish brown to orange, cushiony patches are formed, but in the absence of sporangia (tiny globular heads on fine, dense reddish hairs) the leaf spots remain greenish brown. Occasionally citrus fruits as well as leaves are attacked.

The sporangia formed on the fine hairs germinate in moist weather, producing zoospores that enter through stomata and form mycelium-like chains of algal cells in host tissue. On twigs the alga invades outer cortical tissue, which may swell abnormally, crack, and afford entrance to injurious fungi. Weakened trees are most susceptible, and disease spread is most rapid in periods of frequent and abundant rains. Twigs may die, and there may be reduced yield of citrus fruit.

Control. Improve draining and other growing conditions; citrus trees sprayed regularly with copper seldom have algal trouble. If it gets started, follow cleanup pruning with a bordeaux mixture spray in December or January. Repeat with bordeaux at start of rainy season or when red stage of the alga is first seen, and spray again 1 month later. A neutral copper may substitute for bordeaux for the last two applications. The copper kills beneficial insects parasitic on scales, but the oil controls the scale insects.

Cephalosporium

Deuteromycetes, Hyphomycetes

Conidiophores slender or swollen, simple; conidia hyaline, one-celled, produced successively at the tip and collecting in a slime drop, produced endogenously in some species; saprophytic or parasitic, some species causing vascular wilts of trees.

Cephalosporium apii. **Celery Brown Spot**, a new disease first reported from Colorado in 1943, later from New York and Ohio. Irregular light tan or reddish brown shallow lesions are formed on celery leaf stalks, petioles, and leaflets. They may unite to make a scurfy brown streak up the inside of the stalk and may develop transverse cracks. Utah and Pascal varieties are most susceptible.

Cephalosporium cinnamomeum. **Leaf Spot** of nephthytis and syngonium. Small circular to irregular spots, reddish brown with pale yellow borders enlarge, with centers becoming gray and papery. In severe cases leaves turn yellow and die. Pick off infected leaves. Maintain low temperature and humidity.
Cephalosporium dieffenbachiae. **Dieffenbachia Leaf Spot**. Small red lesions with dark borders appear on young leaves. Spots sometimes run together, and the whole leaf turns yellow and dies. Infection is often through mealybug wounds. Avoid promiscuous syringing; keep temperature and humidity low; control mealybugs, and ants that transport them.

Cercospora

► Blights.

Cercospora abeliae. **Abelia Leaf Spot**, reported from Louisiana. Irregular purple to brown spots; defoliation.
Cercospora abelmoschi (see *Pseudocercospora abelmoschi*). **Leaf Spot** on okra, hibiscus.
Cercospora albo-maculans (Syn. Cercosporella brassicae) (see *Pseudocercospora capsellae*). **White Spot** of turnip, Chinese cabbage, mustard, and other crucifers, common in the Southeast.
Cercospora althaeina. **Leaf Spot** of hollyhock and abutilon. Spots circular, angular or irregular, 1.5 mm, olivaceous to grayish brown, with the dead tissue falling out. The fungus winters in old plant parts.
Cercospora angulata. **Leaf Spot** on philadelphus, currant, flowering currant, and gooseberry. Circular to angular spots, dingy gray centers, dark purple to nearly black margins.
Cercospora aquilegiae. **Columbine Leaf Spot**, reported from Kansas, Wisconsin, Oregon. Spots circular to elliptical, reddish brown to nearly black; fruiting is on both sides of the leaf.
Cercospora arachidicola (*Mycosphaerella arachidicola*, Teleomorph). **Peanut Early Leaf Spot**. Spots light tan aging to reddish or dark brown with a yellow halo, often confluent. Conidiophores on both sides of the leaf, emerging from stomata or breaking through epidermal cells. Conidia colorless to pale yellow or olive, with 5 to 12 cells. Control with sulfur-copper dust.

Cercospora armoraciae. **Horse-Radish Leaf Spot**. Tan to dingy gray lesions with yellow-brown margin; often slightly zonate.

Cercospora beticola. **Cercospora Leaf Spot** of beet, general on garden and sugar beets, also on swiss chard, spinach. Brown flecks with reddish purple borders become conspicuous spots with ash-gray centers and purple margins. The brittle central tissue often drops out, leaving ragged holes. The spots usually remain small but are often so numerous that foliage is killed. If successive crops of leaves are lost, the crown of the beet root is elongated and roughened. Leaf spotting is of little direct importance except in chard, where foliage is used for greens. The beet root yield is reduced.

The grayish color of the spots is due to long, thin, septate conidia produced on conidiophores protruded through stomata in fascicles or groups, coming from a knotted mass of mycelium resembling a sclerotium. Conidia are spread by rain, wind, tools, and insects. Infection is through stomata; disease spread is most rapid under conditions of high humidity that keep stomata open. Hot weather favors the disease.

Control. Crop rotation is highly important. In a small garden pick off the first spotted leaves.

Cercospora bougainvilleae (see *Cercosporidium bougainvilleae*). **Leaf Spot** first seen in Florida in 1962 and now the most important pathogen of this host.

Cercospora brunkii. **Geranium Leaf Spot**, mostly in the South. Spots are circular, light reddish brown with dark brown borders, sometimes coalescing to kill entire leaf.

Cercospora calendulae. **Calendula Leaf Spot**. Spots run together to blight and kill leaves; plants may be destroyed early in the season. Spores enter through stomata of plants more than a month old.

Cercospora cannabina (see *Pseudocercospora cannabina*). **Leaf Curl and Wilt** on hemp.

Cercospora cannabis. **Leaf Spot** on hemp.

Cercospora capsici. **Pepper Leaf Spot**, **Stem-end Rot**, common in the Southeast, serious in rainy seasons. Spots 1/7 to 1 inch in diameter are first water-soaked then white with dark brown margins. Leaves turn yellow and drop. The fungus grows through the pedicel into fruit, causing a rot of the stem end. Loss of foliage exposes the fruit to sunscald. Spray or dust with copper.

Cercospora circumscissa (*Mycosphaerella cerasella*, Teleomorph). **Leaf Spot**, **Shot Hole** of apricot, plum, cherry, cherry-laurel, oriental cherry,

and chokecherry. Dead spots are somewhat larger than those caused by other shot-hole fungi, but the damage is not serious.

Cercospora citrullina. **Leaf Spot** of watermelon, muskmelon, and other cucurbits. Spots are small, circular, black with grayish centers, occurring first on leaves in center of watermelon hills. On cucumber, muskmelon, and squash the spots are large and ochre-gray. Defoliation of vines causes reduction in fruit size, but the disease is not considered important. Clean up diseased vines; use a 2- or 3-year rotation; spray or dust as for bacterial wilt.

Cercospora concors (see *Mycovellosiella concors*). **Potato Leaf Spot**, **Leaf Blotch**.

Cercospora cornicola. **Dogwood Leaf Spot**, in the Gulf states, often with *Septoria florida*. Spots irregular without definite borders.

Cercospora fusca (see *Sirosporium diffusum*). **Pecan Brown Leaf Spot**, prevalent throughout the pecan belt but minor, serious only with high rainfall and in neglected orchards where trees lack vigor.

Cercospora lathyrina. **Leaf Spot** on pea and sweet pea, in southern states and north to New Jersey and Missouri. Angular to elongate spots have dirty gray centers with a black line border.

Cercospora lythracearum. **Leaf Spot** on crape-myrtle, in Texas. Spots circular, pale brown to gray with a greenish fringe or yellow halo.

Cercospora magnoliae (see *Cercosporidium magnoliae*). (*Mycosphaerella milleri*, Telleomorph). On magnolia in South.

Cercospora melongenae. **Eggplant Leaf Spot**, more common in tropical areas. Yellow lesions change to large brown areas with concentric rings.

Cercospora nandinae. **Nandina Leaf Spot**, one of the few diseases of this usually healthy shrub. Red blotches appear on upper leaf surface with centers of older spots almost black. There is a scant sooty fruiting layer on the undersurface. Reported from Alabama and North Carolina.

Cercospora personata (*Mycosphaerella berkeleyii*, Teleomorph) (see *Phaeoisariopsis personata*). **Peanut Leaf Spot**, general on peanut.

Cercospora piaropi. **Leaf Spot** on water-hyacinths.

Cercospora pittospori. **Pittosporum Leaf Spot**, reported from Mississippi, Florida, Louisiana, and Texas. Spots small, angular, yellow to dull brown, fruiting in fawn-colored effuse patches on lower surface.

Cercospora puderi (see *Pseudocercospora puderi*). **Leaf Spot** on rose, reported from Georgia and Texas.

Cercospora resedae. **Leaf Spot**, **Blight** of mignonette, a rapid disease killing much of the foliage. Numerous small circular spots, pale yellow with

reddish brown borders, run together, discoloring the entire leaf. Spores are spread by wind and rain; lower leaves are most affected.

Cercospora rhododendri (see *Pseudocercospora handelii*). **Rhododendron Leaf Spot**.

Cercospora richardiaecola. **Leaf Spot** on calla lily, sometimes injurious. Spots circular, brown, tan, or gray. Avoid syringing; keep plants well spaced; ventilate greenhouse.

Cercospora rosicola (*Mycosphaerella rosicola*, Teleomorph). **Cercospora Spot** of rose, wherever roses are grown but more important in the South. Spots are circular, 1 to 4 mm, but coalescing to irregular areas, purplish or reddish brown with pale brown, tan, or gray centers. Perithecia are formed in fallen leaves.

Cercospora smilacis. **Smilax Leaf Spot**. Spots are more or less circular up to 1/4 inch, dark purplish red, centers fading with age but margins remaining definite and dark.

Cercospora sojina. **Frog-Eye Disease** of soybean. Typical frog-eye spots are formed on leaves and elongated reddish lesions on stems, changing to brown, gray, or nearly black with age. Pods of late varieties may be infected. The fungus winters on diseased leaves and stems. Seed treatment is not effective; crop rotation is necessary. Early varieties often escape injury. There is a wide difference in varietal susceptibility.

Cercospora symplocarpi. **Leaf Spot** on snowberry, coralberry, and wolfberry. Very small circular to angular spots, uniformly brown or with tan centers and brown margins.

Cercospora sp. **Leaf Spot** on kalanchoë.

Cercospora zebrina. **Leaf and Stem Spot** on bean, cowpea, groundnut, peanut, birdsfoot trefoil and Lespedeza. **Leaf Spot** on clovers

Cercosporidium bougainvilleae (formerly *Cercospora bougainvilleae*). **Leaf Spot** first seen in Florida in 1962 and now the most important pathogen of this host. Lesions are 1 to 5 mm, circular, depressed, with brown or tan centers, reddish brown margins and a diffuse chlorotic area.

Cercosporidium magnoliae (formerly *Cercospora magnoliae*). (*Mycosphaerella milleri*, Telleomorph). On magnolia in South. Leaf spots are small, angular, dark, with narrow yellow halo.

Mycovellosiella concors (formerly *Cercospora concors*). **Potato Leaf Spot**, **Leaf Blotch**. Spots none to large irregular brown areas. Fruiting on undersurface; conidiophores very pale; conidia almost hyaline.

Phaeoisariopsis personata (formerly *Cercospora personata* (*Mycosphaerella berkeleyii*, Teleomorph)). **Peanut Leaf Spot**, general on peanut. Spots are circular, 1 to 7 mm, but may coalesce; dark brown to black, often with a yellow halo. Conidiophores on both sides of the leaf, more numerous on the lower, are arranged concentrically in tufts; the epidermis is ruptured. Spores are pale brown to olivaceous, one- to eight-septate. In wet seasons vines may be nearly defoliated. Primary infections come from ascospores on overwintered peanut leaves. Sulfur dust with 3.5% copper is recommended; apply every 10 to 14 days.

Pseudocercospora abelmoschi (formerly *Cercospora abelmoschi*). **Leaf Spot** on okra, hibiscus. Spots indistinct, but a sooty fruiting of spores on under leaf surface.

Pseudocercospora cannabina (formerly *Cercospora cannabina*). **Leaf Curl and Wilt** on hemp.

Pseudocercospora capsellae (formerly *Cercospora albo-maculans* (Syn. *Cercosporella brassicae*)). **White Spot** of turnip, Chinese cabbage, mustard, and other crucifers, common in the Southeast. Small, pale, circular slightly sunken spots; may coalesce.

Pseudocercospora handelii (formerly *Cercospora rhododendri*). **Rhododendron Leaf Spot**. Angular dark brown spots with grayish down in center. Control seldom necessary.

Pseudocercospora puderi (formerly *Cercospora puderi*). **Leaf Spot** on rose, reported from Georgia and Texas. Spots are circular, to 5 mm, with dingy gray centers, brown or reddish brown margins. Fruiting is chiefly on the upper surface in dense fascicles of short conidia.

Sirosporium diffusum (formerly *Cercospora fusca*). **Pecan Brown Leaf Spot**, prevalent throughout the pecan belt but minor, serious only with high rainfall and in neglected orchards where trees lack vigor. Spots are circular to irregular, reddish brown, often with grayish concentric zones. The fungus winters in old spots on leaves. In Florida the disease appears first in June or July on mature leaves and may cause premature defoliation in October. Stuart variety is particularly susceptible; others are more resistant. Control with one application of bordeaux mixture between May 15 and June 15.

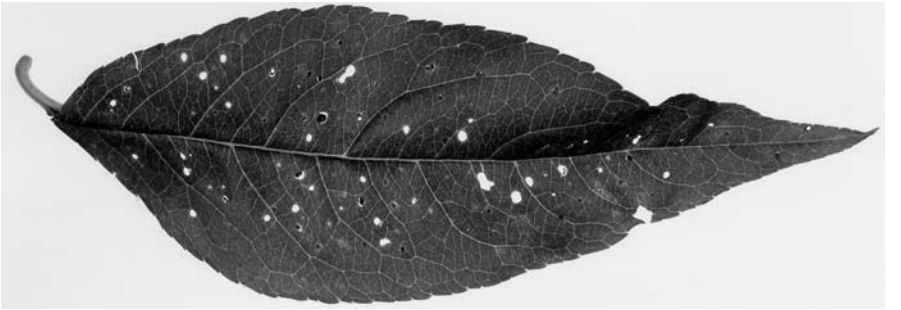

Figure 3.23 Shot-Hole on *Prunus* sp

Cercosporella

Deuteromycetes, Coelomycetes

Conidiophores hyaline, bearing conidia apically or on short branches; conidia hyaline, cylindrical to filiform with several cells (see Figs. 3.23 and 3.24); like *Cercospora* except for light conidiophores; parasitic.

Cercosporella brassicae (see *Pseudocercosporella capsellae*). **Leaf Spot** of cabbage, turnip, mustard, on West Coast.
Pseudocercosporella capsellae (formerly *Cercosporella brassicae*). **Leaf Spot** of cabbage, turnip, mustard, on West Coast. Lesions on cabbage are black, those on turnip and mustard gray with tan margins.

Cercosporidum

Cercosporidium personata (see *Phaeoisariopsis personata*). **Leaf Spot** on peanut.
Phaeoisariopsis personata (formerly *Cercosporidium personata*). **Leaf Spot** on peanut.

Ciborinia

► Blights.

Ciborinia whetzelii (Syn. *Sclerotinia whetzelii*). **Black Leaf Spot** of poplar, **Ink Spot**, from New England States to the Rocky Mountains on

aspen, black poplar, and other species. Saucerlike, thin black sclerotia are formed in leaves, fall to the ground, and produce apothecia in spring. There is often considerable defoliation, and small trees may be killed.
Ciborinia seaveri (*Sclerotinia bifrons*). **Ink Spot**, in western states, producing apothecia on ground under cottonwoods and poplars but pathogenic state confused.

Cladosporium

► Blotch Diseases.

Cladosporium colocasiae. **Leaf Spot** on elephants ear.
Cladosporium echinulatum. **Leaf Spot** on carnation.
Cladosporium epiphyllum. **Leaf Spot** on locust.
Cladosporium oxysporum. **Leaf Spot** on tomato

Blumeriella (Coccomyces)

Ascomycetes, Discomycetes

Blumeriella jaapii (formerly *Coccomyces hiemalis* and *Higginisia hiemalis*). **Cherry Leaf Spot**, **Blight**, **Shoot Hole**, general on sweet and sour cherries, the most common and destructive leaf disease of cherries. Leaf spots are circular, first purplish, then brown, falling out to give the shot-hole effect (see Fig. 3.24). If lesions are numerous, the leaves turn yellow and fall by midsummer, this premature defoliation reducing next season's harvest. The fungus winters in fallen leaves, producing disc-shaped apothecia for primary infection. Secondary infection comes from conidia, formed in whitish masses on the spots in moist weather, more numerous on the undersurface. New infection continues through the summer after harvest. Defoliation prior to ripening reduces size and quality of fruit and exposes it to sunscald. Some seasons shoots, spurs, and branches are killed, followed by a light crop the next year. Thousands of sour cherry trees have been killed.
Control. An eradicant spray of a dinitro compound, such as Elgetol, applied to the ground in early spring, reduces the amount of primary inoculum, but summer sprays are also necessary. On sour cherry this may mean a spray at petal fall, another 10 days later, two sprays in June, and another just after

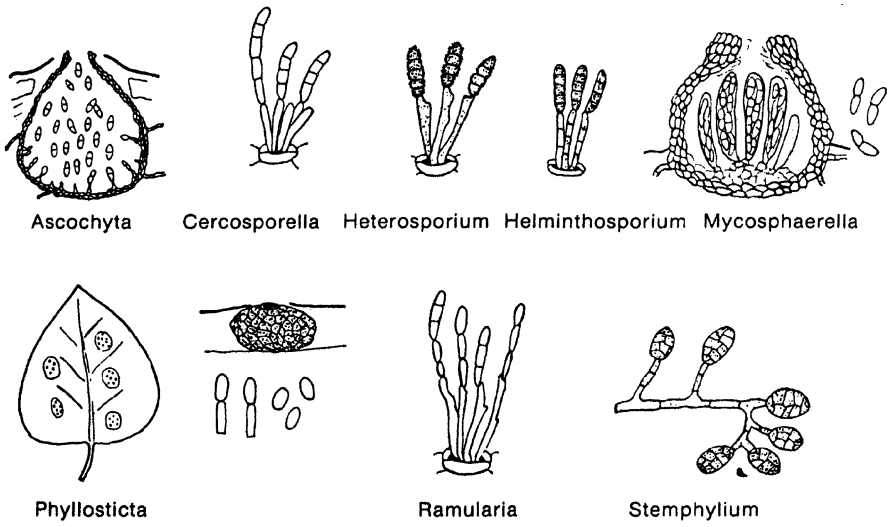

Figure 3.24 Some Leaf-Spot Fungi. *Ascochyta*, hyaline, two-celled conidia in pycnidium; *Cercosporella*, hyaline, septate spores on condiophores emerging from a stoma; *Cladosporium* (formerly *Heterosporium*), spiny, dark, septate spores; *Helmonthosporium*, smooth, dark, septate spores; *Mycosphaerella*, two-celled hyaline ascospores in a perithecium; *Phyllosticta*, hyaline, one-celled conidia in pycnidia formed in spots on leaves; *Ramularia*, hyaline spores, becoming septate, formed successively on conidiophores; *Stemphylium*, colored muriform spores borne free on mycelium

fruit is picked, with more applications, especially on nursery trees, needed in some seasons. Consult your state experiment station for suitable materials and schedule for your area.

Blumeriella jaapii (formerly *Coccomyces lutescens*). **Leaf Spot, Shot Hole** on cherry-laurel, black cherry, and chokecherry. Similar to the disease caused by *C. hiemalis*.

Blumeriella jaapii (formerly *Coccomyces prunophorae*). **Leaf Spot, Shot Hole** on garden plum and apricot. Reddish to brown spots, dark blue initially, produce pinkish spore masses on underside of leaves in wet weather. The shot-hole effect from dropping out of dead tissue may be very prominent and accompanied by heavy fruit drop. Spray when shucks are off young fruit, 2 or 3 weeks later, and before fruit ripens, with lime sulfur, or with wettable sulfur.

Blumeriella kerriae (formerly *Coccomyces kerriae* and *Higginisia kerriae*). **Kerria Leaf Spot, Twig Blight**, widespread on kerris from eastern states to Texas. Leaves have small, round to angular, light brown or reddish brown spots with darker borders. When spots are numerous, leaves turn yellow and die. Similar lesions on young stems may run together into extended cankers,

the bark splitting to show black pycnidia, from which ooze out masses of long, white, curved spores. The fungus winters in old dead leaves. Spraying with bordeaux mixture may help.

Coccomyces hiemalis and **Higginisia hiemalis** (see *Blumeriella jaapii*). **Cherry Leaf Spot**, **Blight**, **Shoot Hole**, general on sweet and sour cherries, the most common and destructive leaf disease of cherries.

Coccomyces kerriae and **Higginisia kerriae** (see *Blumeriella kerriae*) **Kerria Leaf Spot**, **Twig Blight**, widespread on kerria from eastern states to Texas.

Coccomyces lutescens (see *Blumeriella jaapii*). **Leaf Spot**, **Shot Hole** on cherry-laurel, black cherry, and chokecherry.

Coccomyces prunophorae (see *Blumeriella jaapii*). **Leaf Spot**, **Shot Hole** on garden plum and apricot.

Colletotrichum

► Anthracnose.

Colletotrichum acutatum. **Fruit Spot**, **Crown and Petiole Spot** on strawberry.

Colletotrichum coccodes. **Leaf Spot** and **Slight Blight** of velvetleaf.

Colletotrichum dematium f. sp. **truncata**. **Leaf Spot** and **Stem Canker** of *Stylosanthes* spp.

Colletotrichum elastica (see *Colletotrichum gloeosporioides*). **Leaf Spot** on fig (*Fiscus carica*). **Leaf Spot** of basil, flowering dogwood, cyclamen, jasmine, passion flower, leaf and stem spot of calendula and dwarf mistletoe; on many other hosts as anthracnose.

Colletotrichum gloeosporioides (formerly *Colletotrichum elastica*). **Leaf Spot** on fig (*Fiscus carica*). **Leaf Spot** of basil, flowering dogwood, cyclamen, jasmine, passion flower, leaf and stem spot of calendula and dwarf mistletoe; on many other hosts as anthracnose.

Coniothyrium

► Cankers.

Coniothyrium concentricum (see *Microsphaeropsis concentrica*). **Leaf Spot** of century plant and yucca.

Coniothyrium hellebori. **Black Spot** of Christmas rose. Large, irregular, dark brown to black spots on both sides of leaves, often running together with concentric zonation; many leaves turn yellow prematurely and die; plants are weakened and fail to mature the normal number of leaves. Stems may be cankered, shrivel, and fall over, with wilting of unopened flower buds. Open petals sometimes have black spots. In wet weather in spring and fall the disease can spread through an entire planting in 2 or 3 days, but continuous moisture is necessary for infection. Spray with bordeaux mixture.

Coniothyrium pyrina. **Leaf Spot**, **Fruit Spot** of apple, pear.

Microsphaeropsis concentrica (formerly *Coniothyrium concentricum*). **Leaf Spot** of century plant and yucca. Spots are zoned, light grayish brown, an inch or more in diameter, with concentric rings of tiny black pycnidia. Large portions of leaves may be destroyed. Remove and burn diseased leaves.

Corynespora

Deuteromycetes, Hyphomycetes

Hyphae and conidia both dark.

Corynespora cassiicola (Syn. *Helminthosporium vignicola*). **Soy Bean Target Spot**, also on cowpea, tomato, poinsettia, vinca, and privet; general in South. Circular to irregular, reddish brown leaf spots, pin point to 1/4 inch, often zonate and surrounded by yellow-green halos. Fruit necrotic pitting and freckles are also found on infected fruit. Dark brown spots on petioles, pods, and seed. Variety Ogden is moderately resistant. The same fungus causes reddish purple spots on azalea, hydrangea and leaf spots on lipstick vine, and on weeping fig and leaf spot on thyme.

Cristulariella

Deuteromycetes, Moniliales, Moniliaceae

Sterile hyphae decumbent; fertile hyphae hyaline; ascending in a branched head with conidia at tips of intermediate branches; spores globose, hyaline, one-celled.

Cristulariella depraedans. **Leaf Spot** on sugar and other maples. Spots gray, definite or confluent.
Cristulariella moricola. **Zonate Leaf Spot** on Halesia. **Leaf Spot** on hibiscus and tomato.
Cristulariella moricola (Telemorph, *Grovesinia pyramidalis*). **Leaf Spot** on maple, tree-of-heaven, apple, bean, blueberry, cherry, dogwood, hibiscus, sycamore, tung tree, viburnum, walnut, black walnut, beggar-ticks, trumpet vine, Mexican tea, dayflower, blue waxweed, tick clover, mistflower, white snakeroot, morning glory, Indian tobacco, blue cardinal-flower, beefsteak plant, poke, smart weed, false buckwheat, yellow dock, prickly mallow, goldenrod, catbird grape, nectarine, grape, maple, serviceberry and boxelder. Spots yellow-gray with definite margins.

Cryptomycina

Ascomycetes, Rhytismatales

Apothecium splitting irregularly into lobes, hyphal layer thin; spores hyaline, one-celled.

Cryptomycina pteridis. **Tar Spot** of fern, bracken. Spots are usually on lower surface and between veins; leaves may roll.

Cryptostictis

► Blights.

Cryptostictis arbuti (see *Seimatosporium arbuti*). **Leaf Spot** on *Arbutus menziesii, Manzanita*, ledum.
Seimatosporium arbuti (formerly *Cryptostictis arbuti*). **Leaf Spot** on *Arbutus menziesii, Manzanita*, ledum.

Cycloconium

Deuteromycetes, Hyphomycetes

Mycelium coiled, spores small, dark, two-celled; scarcely different from short hyphae.

Cycloconium oleaginum. **Olive Leaf Spot**, **Peacock Spot**, **Ring Spot**. Blackish, more or less concentric rings on leaves, especially those weakened or old.

Cylindrocladium

Deuteromycetes, Hyphomycetes

Conidiophores repeatedly dichotomously or trichotomously branched, each terminating in two or three phialides (cells developing spores); conidia hyaline, with two or more cells, cylindrical, borne singly; parasitic or saprophytic.

Cylindrocladium avesiculatum. **Leaf Spot** and **Twig Dieback** on holly, and *Leucothoë* sp.
Cylindrocladium colhounii. **Leaf Spot** on bottle-brush (Callistemon).
Cylindrocladium clavatum. **Leaf Spot** on bottle-brush (Callistemon).
Cylindrocladium pteridis. **Leaf Spot**, **Leaf Blight** of Washington palm. Numerous small dark brown spots with light margins are somewhat disfiguring.
Cylindrocladium pteridis. **Fern Leaf Spot**, **Leaf Blotch**. Reddish brown lesions run together to cover large areas. Pick off and burn infected fronds.

Cylindrosporium

Deuteromycetes, Coelomycetes

Acervuli subepidermal, white or pale; conidiophores short, simple; conidia hyaline, filiform, straight or curved, one-celled or septate; parasitic on leaves.

Cylindrosporium betulae. **Brown Leaf Spot** of Birch. Sometimes serious enough to defoliate but not often present on ornamental trees.
Cylindrosporium chrysanthemi. **Chrysanthemum Leaf Spot**. Spots are dark brown with yellowish margins, increasing to take in the whole leaf, which hangs down. Similar to more common Septoria leaf spot.
Cylindrosporium clematidinis. **Clematis Leaf Spot**. Reddish brown spots on lower leaves, which may drop. Dusting with sulfur has been suggested.
Cylindrosporium salicinum. **Willow Leaf Spot**. Sometimes causing defoliation; can be controlled with bordeaux mixture if necessary.
Cylindrosporium sp. **Leaf Spot** on spirea, recorded from a Kansas nursery. Light yellow lesions turn dark brown, with masses of yellow conidia on underside.

Cytospora

► Cankers.

Cytospora sp. **Leaf Spot** on mulberry.

Dactylaria

Dactylaria higginsii. **Leaf Spot** on nutsedge.

Dichotomophthoropsis

Deuteromycetes, Hyphomycetes

Dichotomophthoropsis nymphaearum. **Leaf Spot** on water-lily, and water shield.

Didymaria

Deuteromycetes, Hyphomycetes

Conidiophores simple, arising from leaf surface in loose groups; conidia hyaline, two-celled, ovate-oblong, borne singly; parasitic on leaves.

Didymaria didyma (see *Ramularia didyma*). **Leaf Spot** on anemone. Angular brown spots.
Ramularia didyma (formerly *Didymaria didyma*). **Leaf Spot** on anemone. Angular brown spots.

Didymellina

Acomycetes, Sphaeriales, Mycosphaerellaceae

Perithecia separate, innate or finally erumpent, not beaked; spores two-celled, hyaline.

Didymellina macrospora (*Heterosporium iridis, H. gracilis*) (see *Mycosphaerella macrospora*, Anamorph). **Irish Leaf Spot**, **Blotch**, **Fire** on both bulbous and rhizomatous iris.
Didymellina ornithogali (*Heterosporium ornithogali*) (see *Mycosphaerella ornithogali*). **Leaf Spot** on star-of-bethlehem.

Didymellina poecilospora. A weak parasite sometimes causing black discoloration of iris foliage.

Mycosphaerella macrospora (formerly *Didymellina macrospora*; *Heterosporium iridis, H. gracilis*, Anamorph). **Irish Leaf Spot**, **Blotch**, **Fire** on both bulbous and rhizomatous iris. The spotting is conspicuous toward the end of the season but is not too serious in a normally dry season. Usually the spots are confined to the upper half of leaves, but if plants are crowded and shaded and the summer is wet, the spotting appears earlier, covers more of the leaf, and is more damaging.

Spots are dark brown at first, surrounded by a water-soaked and then yellowing region; they enlarge into rather oval lesions, up to 1/2 inch long, with a red-brown border (Fig. 3.25). Flower buds and stems of bulbous iris may be attacked. Tufts of olive conidia turn the centers grayish, the spores being produced in abundance and splashed by rain to neighboring leaves. Infection is through stomata or directly through the epidermis. The fungus winters as mycelium in old leaves, and in spring produces a fresh crop of conidia or perithecia of the *Didymellina* stage. Soils deficient in lime apparently favor

Figure 3.25 Iris Leaf Spot

the disease. Repeated spotting reduces bloom and, after a number of years, may kill plants.
Control. It is often sufficient to remove and burn all old leaves at the end of the season; shearing back spotted leaves in midsummer is helpful. If the disease is regularly a problem, spray with bordeaux mixture, starting when fans are 6 to 8 inches high and repeating at 10- to 14-day intervals.
Mycosphaerella ornithogali (formerly *Didymellina ornithogali*; *Heterosporium ornithogali*, Anamorph). **Leaf Spot** on star-of-bethlehem. Occasional sooty spots on leaves, with foliage blackened and killed in severe infections.

Didymosporium

Deuteromycetes, Coelomycetes

Conidia are slime-spores in acervuli; dark, two-celled.

Didymosporium arbuticola. **Leaf Spot** on *Arbutus menziesii*.

Dilophospora

Deuteromycetes, Coelomycetes

Pycnidia distinct in a stroma; conidia very long, filiform, with bristlelike hairs at each end. Usually found on cereals and sometimes with the wheat nematode, causing a disease called twist.

Dilophospora geranii (see *Pestalozziella subsessilis*). **Leaf Spot** on native geranium.
Pestalozziella subsessilis (formerly *Dilophospora geranii*). **Leaf Spot** on native geranium.

Diplodina

Deuteromycetes, Coelomycetes

Pycnidia black, separate, immersed or erumpent, globose or flattened, ostiolate; conidiophores simple, slender; conidia hyaline, two-celled, ovoid or ellipsoid; parasitic or saprophytic. Similar to *Ascochyta* but not produced in spots.

Diplodia rhododendri (see *Encoeliopsis rhododendron*). **Leaf Spot** on rhododendron.

Encoeliopsis rhododendron (formerly *Diplodia rhododendri*). **Leaf Spot** on rhododendron.

Diplotheca (Stevensea)

Ascomycetes, Myriangiales

Asci born singly in locules at various levels in a massive stroma; spores dark, several-celled.

Diplotheca wrightii. **Black Spot**, **Charcoal Spot** of Opuntia cacti in Florida and Texas uncommon in the North. Dark spots, 1/4 inch or more in diameter, are surrounded by a ring of fruiting bodies.

Dothichiza

► Cankers.

Dothichiza caroliniana. **Leaf Spot**, **Double Spot** of blueberry, found only on *Vaccinium australis* in North Carolina, but there causing extensive defoliation. Leaf spots are small, circular, with brown centers and a dark brown ring, but in late summer infection spreads to a secondary necrotic area around the original spot, giving the common name of double spot. Black pycnidia are formed sparsely in the spots. All varieties of high bush blueberries are somewhat susceptible, but Cabot, Dixie, Pioneer, and Rancocas are most damaged.

Ectostroma

Deuteromycetes, Hyphomycetes

Black stromata formed in leaves and stems.

Ectostroma liriodendri. **Tar Spot**, widespread in tulip-trees but perhaps secondary after insect injury.

Epicoccum

Deuteromycetes, Hyphomycetes

Sporodochia dark, rather cushion-shaped; conidiophores compact or loose, rather short; conidia dark, with one or more cells, globose; mostly saprophytic.

Epicoccum asterinum (see *Epicoccum nigrum*). **Leaf Spot** of yucca; *E. neglectum*, on royal palm; *E. nigrum*, on *Magnolia grandiflora*; *E. purpurascens*, on amaryllis.
Epicoccum nigrum (formerly *Epicoccum asterinum*). **Leaf Spot** of yucca; *E. neglectum*, on royal palm; *E. nigrum*, on *Magnolia grandiflora*; *E. purpurascens*, on amaryllis. All of these may be secondary infections. *E. neglectum* and *E. purpurascens* are also synonyms of *E. nigrum*.

Exosporium

Deuteromycetes, Hyphomycetes

Conidia on subglobose to convex sporodochia; spores dark, with two to several cells, somewhat club-shaped.

Discogloeum concentricum (formerly *Exosporium concentricum*). **Leaf Spot** on euonymus and ligustrum (privet) in the South.
Exosporium concentricum (see *Discogloeum concentricum*). **Leaf Spot** on euonymus and ligustrum (privet) in the South.

Fusicladium

Deuteromycetes, Hyphomycetes

Mycelium forming a stroma under cuticle of host; conidiophores dark, short; conidia dark, two-celled, produced successively as pushed-out ends of new growing tips. Parasitic on higher plants, causing scab as well as leaf spots.

Fusicladium pisicola. **Black Leaf** of peas, first reported in Utah in 1921, causing trouble with canning peas. Spots start as small, irregular whitish areas on undersurface of leaflets and stipules, but they darken to gray or black from the closely packed layer of dark conidia. The disease is not very important.
Fusicladium robiniae (see *Phaeoisariopsis robiniae*). **Leaf Spot**, **Seedling Leaf Blight** of black locust.
Phaeoisariopsis robiniae (formerly *Fusicladium robiniae*). **Leaf Spot**, **Seedling Leaf Blight** of black locust. Spots are small, with light centers and dark margins. There is frequently defoliation of seedlings, sometimes stunting and death.

Gibbago

Deuteromycetes, Hyphomycetes

Gibbago trianthemae. **Leaf Spot** of horse purslane; a new genus and species, recently described (1986), with potential for bioherbicide activity.

Gloeocercospora

Deuteromycetes, Hyphomycetes

Sporodochia formed on surface of host above stomata from hyphae emerging through openings; conidiophores hyaline, simple or branched; conidia hyaline, elongate to filiform, one- to many-septate, straight or curved, in a slimy matrix.

Gloeocercospora inconspicua. **Leaf Spot** of highbush and rabbit-eye blueberry. Circular to angular brownish spots on leaves, with sporodochia more frequent on upper surface. These are flat discs when dry, glistening globules when wet, containing curved, septate conidia.
Gloeocercospora sorghi. **Copper Spot** of turf. (► *Ramulispora sorghi*).

Gloeosporium

► Anthracnose.

Asteroma inconspicuum (formerly *Gloeosporium inconspicuum*). **Elm Leaf Spot**, **Twig Blight**, **Anthracnose** on American and English elms. Subcircular brown spots with darker margins and centers are visible on upper and lower leaf surfaces.
Cryptocline betularum (formerly *Gloeosporium betularum*). **Leaf Spot**, **Anthracnose** of river birch. Spots are more or less circular, 1/8 inch across, brownish with pale centers and yellow margins.
Gloeosporium betularum (see *Cryptocline betularum*). **Leaf Spot**, **Anthracnose** of river birch.
Gloeosporium inconspicuum (see *Asteroma inconspicuum*). **Elm Leaf Spot**, **Twig Blight**, **Anthracnose** on American and English elms.
Gloeosporium mezerei (see *Marssonina daphnes*). **Leaf Spot** on daphne.
Gloeosporium rhododendri. **Leaf Spot** on rhododendron, tulip-tree.

Gloeosporium ulmicola. **Elm Leaf Spot**. Elongated spots on midribs, veins, and margins, visible on both leaf surfaces.
Marssonina daphnes (formerly *Gloeosporium mezerei*). **Leaf Spot** on daphne. Small brown spots on both sides of leaves.

Glomerella

► Anthracnose.

Glomerella cingulata. **Leaf Spot**, widespread on queen palm, dracaena, and maranta. Sobralia blight of orchids. Dark discoloration starts at tip of leaves and advances toward base.
Glomerella cingulata. **Leaf Spot** on apple, aucuba, wampi, and croton. See under Anthracnose for this fungus on many other hosts.
Glomerella sp. **Black Spot** of Vanda orchids.

Gnomonia

► Anthracnose.

Gnomonia comari. **Leaf Spot/Blotch** and **Fruit Rot** of strawberry.
Gnomonia fragariae. **Leaf Spot**, **Leaf Blotch** of strawberry. Often associated with *Dendrophoma* causing leaf blight, but not connected.
Gnomonia nerviseda (formerly *Gnomonia caryae* var. *pecanae*). **Pecan Liver Spot**. Dark brown circular spots, mostly along midribs on underside of leaves, appear in May and June. In autumn the color changes to cinnamon brown, and dark fruiting bodies appear; there may be premature defoliation. Spray in May with bordeaux mixture.
Pecan Vein Spot. Lesions resemble pecan scab on veins or leaf stems; sometimes a narrow brown lesion extends nearly the length of a midrib. Defoliation may be moderate or severe. Stuart variety is especially susceptible. Spray with bordeaux mixture just before and just after pollination; repeat 3 to 4 weeks later.
Gnomonia ulmea, Anamorph, *Gloeosporium ulmeum* (see *Stegophora ulmea*). **Elm Black Spot**, **Black Leaf Spot** of Elm, general on American, English, and Chinese elms.
Gnomonia caryae var. **pecanae** (see *Gnomonia nerviseda*). **Pecan Liver Spot**.

Stegophora ulmea (formerly *Gnomonia ulmea*, Anamorph, *Gloeosporium ulmeum*). **Elm Black Spot**, **Black Leaf Spot** of Elm, general on American, English, and Chinese elms. Spots on leaves are small but conspicuous, shining coal black, and slightly raised. Leaves may turn yellow and drop, with severe defoliation in a wet season, especially on Siberian elm. Defoliation in spring means death of twigs, but the disease is more common and less important toward fall. Ascospores are formed in spring in perithecia on fallen dead leaves; conidia are produced as a creamy exudate of spores in summer. The fungus also winters as mycelium in dormant buds.
Control. Rake and burn fallen leaves. Chemical control is required only in a wet spring, difficult to determine in advance.

Gnomoniella

Ascomycetes, Diaporthales

Perithecia in substratum, beaked, membranous, separate; spores hyaline, one-celled.

Gnomoniella coryli (see *Mamianiella coryli*). **Leaf Spot** on hazel, frequent in northern states.
Gnomoniella fimbriata (see *Mamianiella fimbriata*). **Leaf Spot** of hornbeam.
Mamianiella coryli (formerly *Gnomoniella coryli*). **Leaf Spot** on hazel, frequent in northern states. Controlled with bordeaux mixture aided by cleaning up fallen leaves.
Mamianiella fimbriata (formerly *Gnomoniella fimbriata*). **Leaf Spot** of hornbeam.

Gonatobotryum

Deuteromycetes, Hyphomycetes

Conidiophores dark, with spiny inflations at intervals, around which are borne ovoid, dark, one celled conidia.

Gonatobotryum apiculatum. **Leaf Spot** on witchhazel.

Graphium

Deuteromycetes, Hyphomycetes

Synnema or coremium tall, dark, with a rounded terminal mass of conidia embedded in mucus; simple, hyaline conidiophores; oblong conidia reproducing by budding; parasitic.
Graphium sorbi. **Leaf Spot** of mountain-ash.

Guignardia

► Blotch Diseases.

Guignardia bidwellii f. sp. **parthenocissi**. **Leaf Spot** on Boston ivy, pepper-vine, and Virginia creeper. Spots are numerous, angular, reddish brown, usually dark brown at margins, with black dots in center, minute pycnidia of the anamorph *Phyllosticta* state. Leaves are quite unsightly and there may be defoliation. Bordeaux mixture applied two or three times, starting as leaves are expanding, gives some control, but the "cure" looks about as bad as the disease. This fungus is a form of the species causing black rot of grapes.

Helminthosporium

► Blights.

Bipolaris cynodontis (formerly *Helminthosporium cynodontis*). **Bermuda Grass Leaf Blotch**, general in South. Olive brown indefinite lesions on dry leaves.
Bipolaris setariae (formerly *Helminthosporium setariae* (*Drechslera setariae*)). **Leaf and Petal or Greasy Spot** on geranium, areca palm, fishtail palm, rhapis palm, *Calathea* spp. *Maranta* spp., and *Chamaedorea* spp.
Bipolaris sorokiniana (formerly *Helminthosporium sativum*). **Melting-out**, prevalent on bent grass in warm weather. **Leaf Spot** on Russian wildrye (*Elymus*); **Spot Blotch** on switchgrass (*Panicum*).
Bipolaris sorokiniana (formerly *Helminthosporium sorokiniana*). **Leaf Spot** and **Stem Spot** of wild rice. **Leaf and Pod Spot** on bean.
Drechslera catenaria (formerly *Helminthosporium catenarium*). **Leaf Spot** on ribbon-grass.
Drechslera dictyoides (formerly *Helminthosporium dictyoides*). **Fescue Netblotch**, general on fescue. Dark streaks across green leaves with darker lengthwise streaks form a net pattern. Leaves turn yellow and die back from tips.

Drechslera erythrospilum (formerly *Helminthosporium erythrospilum*). **Red Leaf Spot** on redtop and bent grasses, widespread in eastern and midwestern states. Under wet conditions lesions have small, pale centers with russet borders; in dry weather leaves wither as in drought but with less evident spotting. Conidia are typically cylindrical, rounded at both ends, yellowish, and germinate from any or all cells (see Fig. 3.23).

Drechslera giganteum (formerly *Helminthosporium giganteum*). **Zonate Leaf Spot**, **Eye Spot** on bent grasses, Canada and Kentucky bluegrass, and Bermuda grass. The disease is present in turf and in nursery rows. Spots are small, 1/16 to 1/8 inch, bleached-straw color in centers. In presence of moisture (dew is sufficient) the fungus grows periodically into new areas, giving the zoned appearance. In continued wet weather leaves are killed and grass turns brown. Metropolitan and velvet bent grasses are less susceptible. Most injury is in July and August. The fungus overwinters as dormant mycelium in old leaves.

Drechslera poae (formerly *Helminthosporium vagans*). **Bluegrass Leaf Spot**, **Going-Out**, **Melting-out**, **Foot Rot**, general but most injurious in northeastern states, on bluegrass only. Scattered circular to enlongate leaf spots, 0.5 to 3 by 1 to 8 mm, have prominent reddish brown to black borders; centers are brown changing to straw-colored or white with age. The disease, favored by cool rainy weather, usually appears in early spring, sometimes in late fall, and is most severe on close-clippped turf. Grass thins out in large areas; roots rot; weeds invade exposed soil.

Control. Merion bluegrass is quite resistant to leaf spot and will stand close-clipping. For other bluegrasses cut high and fertilize well to help turf withstand the disease.

Drechslera siccans (formerly *Helminthosporium siccans*; Teleomorph, *Pyrenophora lolii*). **Brown Blight** on fescue, and ryegrass. Leaves die back with numerous dark chocolate-brown spots, oval to elongate and often coalescing. The disease appears in early spring in cool, moist weather.

Drechslera stenacra (formerly *Helminthosporium stenacrum*). **Leaf Mold** on redtop and bent grasses. Indefinite spots; leaves dry, withered, in fall.

Drechslera triseptata (formerly *Helminthosporium triseptatum*). **Leaf Spot**, **Gray Leaf Mold** on redtop, spike and bentgrasses in Oregon, Washington, and New York. Leaf tips are killed with vague lesions; gray mold appears on dying tissue.

Drechslera tritici-repentis (formerly *Helminthosporium tritici-repentis*). **Leaf Spot** on Russian wildrye (*Elymus*).

Exserohilum rostratum (formerly *Helminthosporium rostratum*). **Leaf Spot** on bromelia, areca palm, fishtail palm, rhapis palm, sweet sorghum, and *Chamaedorea* spp.
Helminthosporium catenarium (see *Drechslera catenaria*). **Leaf Spot** on ribbon-grass.
Helminthosporium cynodontis (see *Bipolaris cynodontis*). **Bermuda Grass Leaf Blotch**, general in South.
Helminthosporium dictyoides (see *Drechslera dictyoides*). **Fescue Net-blotch**, general on fescue.
Helminthosporium erythrospilum (see *Drechslera erythrospilum*). **Red Leaf Spot** on redtop and bent grasses, widespread in eastern and midwestern states.
Helminthosporium giganteum (see *Drechslera giganteum*). **Zonate Leaf Spot**, **Eye Spot** on bent grasses, Canada and Kentucky bluegrass, and Bermuda grass.
Helminthosporium rostratum (see *Exserohilum rostratum*). **Leaf Spot** on bromelia, areca palm, fishtail palm, rhapis palm, sweet sorghum, and *Chamaedorea* spp.
Helminthosporium sativum (see *Bipolaris sorokiniana*). **Melting-out**, prevalent on bent grass in warm weather. **Leaf Spot** on Russian wildrye (*Elymus*); **Spot Blotch** on switchgrass (*Panicum*).
Helminthosporium setariae (*Drechslera setariae*) (see *Bipolaris setariae*). **Leaf and Petal or Greasy Spot** on geranium, areca palm, fishtail palm, rhapis palm, *Calathea* spp. *Maranta* spp., and *Chamaedorea* spp.
Helminthosporium siccans; Teleomorph, *Pyrenophora lolii* (see *Drechslera siccans*). **Brown Blight** on fescue, and ryegrass.
Helminthosporium sorokiniana (see *Bipolaris sorokiniana*). **Leaf Spot** and **Stem Spot** of wild rice. **Leaf and Pod Spot** on bean.
Helminthosporium stenacrum (see *Drechslera stenacra*). **Leaf Mold** on redtop and bent grasses.
Helminthosporium triseptatum (see *Drechslera triseptata*). **Leaf Spot**, **Gray Leaf Mold** on redtop, spike and bentgrasses in Oregon, Washington, and New York.
Helminthosporium tritici-repentis (see *Drechslera tritici-repentis*). **Leaf Spot** on Russian wildrye (*Elymus*).
Helminthosporium vagans (see *Drechslera poae*). **Bluegrass Leaf Spot**, **Going-Out**, **Melting-out**, **Foot Rot**, general but most injurious in northeastern states, on bluegrass only.

Hendersonia

Deuteromycetes, Coelomycetes

Pycnidia smooth, innate or finally erumpent, ostiolate; conidia dark, several-celled, elongate to fusoid; saprophytic or parasitic.

Hendersonia concentrica. **Leaf Spot** on rhododendron.
Hendersonia crataegicola. **Leaf Spot** on hawthorn. Spots irregular, dark brown.

Cladosporium (Heterosporium)

Deuteromycetes, Hyphomycetes

Conidiophores dark, simple; conidia dark, spiny, cylindrical, with three or more cells; parasitic, causing leaf spots, or saprophytic.

Acroconidiella escholtziae (formerly *Heterosporium escholtziae*). **Capsule Spot**, **Leaf Spot**, **Stem Spot** of California poppy. Lesions faint purplish brown; seed capsules may shrivel. Treat seed with hot water, 125°F, for 30 minutes.
Cladosporium allii (formerly *Heterosporium allii*). **Leaf Spot** on onion, leek, shallot, chive, and garlic; rare in North America. Leaves have elliptical, depressed, pale brown spots, and yellow and wither from tip downward.
Cladosporium echinulatum (formerly *Heterosporium echinulatum*). **Fairy Ring Spot**, **Leaf Mold** on carnation, occasional in greenhouses. Bleached spots on leaves have black spore groups in ring formation. Syringe as little as possible and on bright days; control ventilation.
Cladosporium iridis (formerly *Heterosporium gracile*). **Leaf Spot** on chlorogalum, daylily, same as *H. iridis* on iris (conidial state of *Didymellina macrospora*). **Leaf Spot** on iris, blackberry, lily, freezia, and gladiolus.
Cladosporium variabile (formerly *Heterosporium variabile*). **Leaf Spot**, pinhead "rust" of spinach, cabbage mold, sometimes severe in cold, wet weather. Circular, chlorotic spots with brown or purple margins enlarge and multiply until they cover most of the leaf, which turns yellow, withers, dies. There is a greenish black mold on both leaf surfaces, made up of large olive conidia, one- to six-celled, covered with warts. Keep plants growing vigorously in wall-drained soil.

Heterosporium allii (see *Cladosporium allii*). **Leaf Spot** on onion, leek, shallot, chive, and garlic; rare in North America.
Heterosporium echinulatum (see *Cladosporium echinulatum*). **Fairy Ring Spot**, **Leaf Mold** on carnation, occasional in greenhouses.
Heterosporium escholtziae (see *Acroconidiella escholtziae*). **Capsule Spot**, **Leaf Spot**, **Stem Spot** of California poppy.
Heterosporium gracile (see *Cladosporium iridis*). **Leaf Spot** on chlorogalum, daylily, same as *H. iridis* on iris (conidial state of *Didymellina macrospora* (Fig. 3.25)). **Leaf Spot** on iris, blackberry, lily, freezia, and gladiolus.
Heterosporium variabile (see *Cladosporium variabile*). **Leaf Spot**, pinhead "rust" of spinach, cabbage mold, sometimes severe in cold, wet weather.

Illosporium

Deuteromycetes, Hyphomycetes

Sporodochia cushionlike, light-colored; conidiophores hyaline, branched with phialides bearing conidia apically; spores hyaline, one-celled; parasitic or saprophytic, often secondary.

Illosporium malifoliorum. **Leaf Spot** of apple and crabapple.

Isariopsis

Deuteromycetes, Hyphomycetes

Dark, synnemata composed of loose conidiophores with spores at or near tips; conidia dark or pale, with two or more cells, cylindrical to obclavate, often curved; parasitic.

Isariopsis griseola (see *Phaeoisariopsis griseola*). **Angular Leaf Spot**, **Pod Spot** of beans, also sweet pea.
Phaeoisariopsis griseola (formerly *Isariopsis griseola*). **Angular Leaf Spot**, **Pod Spot** of beans, also sweet pea. Small, angular brown spots are so numerous they give a checkerboard appearance to leaves. The fungus forms a gray moldy covering over dead areas on underside of leaves. Pod spots are conspicuous when present, black with red or brown centers, varying from a speck to the width of the pod. Small, dark synnemata scattered over

the surface bear large conidia, with two to four cells, at top of stalks. They are probably wind-disseminated. Control measures are seldom practical. Also, **Leaf Spot** on kidney bean.

Kabatia

Deuteromycetes, Coelomycetes

Pycnidia with a radiate shield or scutellum, with an ostiole; spores two-celled, hyaline, like a tooth at the apex.

Kabatia lonicerae. **Leaf Spot** on honeysuckle.

Lasiobotrys

Ascomycetes, Dothideales

Perithecia in a ring around a sclerotial stroma; spores dark, two-celled.

Lasiobotrys lonicerae. **Leaf Spot** on honeysuckle. Spot is well-marked with small, dark, wartlike stromas.

Leptostromella

Deuteromycetes, Coelomycetes

Pycnidia elongate, with a cleft; separate; spores filiform, with rounded ends, hyaline, continuous to septate on simple conidiophores.

Leptostromella elastica. **Leaf Spot** of rubber-plant. The symptoms appear in spots and streaks, but infection spreads until the entire leaf is involved. Black lines outline spots in which small black pycnidia produce long, colorless spores. Remove and burn infected leaves.

Leptothyrella

Deuteromycetes, Coelomycetes

Pycnidia with a radiate shield, separate; spores 2-celled, hyaline.

Leptothyrella liquidambaris (see *Tubakia dryina*). **Leaf Spot** red on sweetgum.
Tubakia dryina (formerly *Leptothyrella liquidambaris*). **Leaf Spot** red on sweetgum.

Leptothyrium

Deuteromycetes, Coelomycetes

Pycnidium flattened with a more or less radiate shield, opening with a ostiole; spores one-celled, hyaline, on simple conidiophores.

Kabatia periclymeni (formerly *Leptothyrium periclymeni*). **Leaf Spot** on honeysuckle, widespread.
Leptothyrium californicum. **Leaf Spot** on coast live oak.
Leptothyrium dryinum (see *Tubakia dryina*). **Leaf Spot** on white oak.
Leptothyrium periclymeni (see *Kabatia periclymeni*). **Leaf Spot** on honeysuckle, widespread.
Tubakia dryina (formerly *Leptothyrium dryinum*). **Leaf Spot** on white oak.

Linospora

Ascomycetes, Diaporthales

Perithecia innate, beak often lateral, with a shield; paraphyses lacking; spores spindle-shaped to filiform, hyaline.

Linospora gleditschiae. **Leaf Spot**, **Tar Spot** on honey locust in the South. Numerous black fruiting bodies are formed on undersurface of leaves.

Lophodermium

Ascomycetes, Rhytismatales

Fruiting body a hysterothecium, midway between an elongated perithecium and a compressed apothecium, hard, black, opening with a long narrow slit; paraphyses present; hooked at tip; spores filiform, septate or continuous. Most species cause needle casts.

Lophodermium schweinitzii. **Rhododendron Leaf Spot**. Large silvery white spots with red, raised margins have very prominent oval, black fruiting bodies on the upper surface. Lower side of spots is a light chocolate brown.

Infected portions may fall out, leaving irregular holes. The disease is more common on native than on hybrid varieties.

Macrophoma

► Cankers.

Macrophoma candollei. **Leaf Spot** of boxwood. Conspicuous black pycnidia on dead leaves, usually straw-colored, sometimes brown or tan. The fungus is a weak parasite coming in secondarily after winter injury or other predisposing factors.

Marssonina

► Anthracnose.

Cylindrosporium populinum (formerly *Marssonina rhabdospora*; Teleomorph, *Pleuroceras populi*). **Leaf Spot** of poplar. Brown spots on living leaves; beaked pyriform perithecia formed in fallen leaves over winter.
Didymosporina aceris (formerly *Marssonina truncatula*). **Leaf Spot** and **Leaf Blight** of Norway maple.
Diplosporonema delastrei (formerly *Marssonina delastrei*). **Leaf Spot** on corncockle and campion.
Discella ochroleuca (formerly *Marssonina ochroleuca*). **Leaf Spot** on oak, American chestnut. Spots are circular, yellow to brown with concentric markings, small on chestnut, up to an inch on oak.
Marssonina daphnes. **Daphne Leaf Spot**. Small, thick brown spots on both sides of leaf, which turns yellow, dies.
Marssonina delastrei (see *Diplosporonema delastrei*). **Leaf Spot** on corncockle and campion.
Marssonina fraxini (see *Piggotia fraxini*). **Ash Leaf Spot**, sometimes serious in nursery stock, controlled by spraying with bordeaux mixture.
Marssonina juglandis. See *Gnomonia leptostyla* under Anthracnose.
Marssonina ochroleuca (see *Discella ochroleuca*). **Leaf Spot** on oak, American chestnut.
Marssonina populi. **Poplar Leaf Spot**. Brown spots with darker margins. There may be premature defoliation and killing of twigs.

Marssonina rhabdospora (Teleomorph, *Pleuroceras populi*) (see *Cylindrosporium populinum*). **Leaf Spot** of poplar.
Marssonina rosae. Anamorph state of the rose blackspot fungus, *Diplocarpon rosae*.
Marssonina tremulae. **Leaf Spot** on poplar.
Marssonina truncatula (see *Didymosporina aceris*). **Leaf Spot** and **Leaf Blight** of Norway maple.
Piggotia fraxini (formerly *Marssonina fraxini*). **Ash Leaf Spot**, sometimes serious in nursery stock, controlled by spraying with bordeaux mixture.

Mastigosporium

Deuteromycetes, Hyphomycetes

Conidiophores hyaline, very short, simple; conidia with four or more cells, with or without apical appendages: broadly cylindrical with rounded or pointed ends; parasitic on grasses.

Mastigosporium rubricosum. **Leaf Fleck** on redtop and bent grasses. Spores with rounded ends, without appendages.

Melanconium

Deuteromycetes, Coelomycetes

Acervuli subcutaneous or subcortical, conic or discoid, black; with setae; conidiophores simple; conidia dark, one-celled, ovoid to ellipsoid; parasitic or saprophytic.

Melanconium pandani. **Leaf Spot** on pandanus.

Melasmia

Deuteromycetes, Coelomycetes

Pycnidia in a broad, black, flattened stroma that is superficial or nearly so, dimidiate; conidiophores simple or branched; spores hyaline or subhyaline, one-celled, allantoid or fusoid; parasitic on leaves; anamorph states of *Rhytisma*.

Melasmia falcata. **Tar Spot** of persimmon.
Melasmia menziesiae. **Leaf Spot** tar spot of azalea.

Micropeltis

► Blights.

Micropeltis alabamensis. **Black Leaf Spot** on magnolia.

Microstroma

Basidiomycetes, Exobasidiales

Sporodochia small, white, breaking through epidermis; conidiophores hyaline, one-celled, somewhat clavate, bearing conidia on short sterigmata; spores hyaline, one-celled, small, oblong; parasitic. "Conidia" are now known to be basidiospores.

Microstroma juglandis. **Leaf Spot**, **White Mold**, **Downy Spot**, **Witches' Broom** of pecan, walnut, and hickory. Yellow blotching of upper side of leaves and a glistening white coating on underside, due to pustules with enormous numbers of spores, may be accompanied by premature defoliation. On shagbark hickory the fungus also invades the stems, causing witches' brooms up to 3 feet across. Leaves formed on them in spring are yellow-green, with white powder on underside. Leaflets are small, curled, and soon drop. Prune out witches' brooms; spray with bordeaux mixture.

Microthyriella

► Fruit Spots.

Microthyriella cuticulosa. **Black Spot** of holly. Dark spots on leaves of American holly, Georgia.

Monochaetia

► Cankers.

Monochaetia monochaeta. **Leaf Spot** on chestnut, white, red, and coast live oaks, winged elm, hickories, especially destructive in the Southeast. Spots are large, 1 to 2 inches in diameter, with pale green or yellow centers with a red and brown border or concentric zones of gray, yellow, and brown.

Symptoms appear most often in late summer when loss of green tissue is not so important.

Lembosina (Morenoella)

See *Lembosia* under Black Mildew.

Lembosina quercina (formerly *Morenoella quercina*). **Leaf Spot, Black Mildew** of red and black oaks; twig blight of white oak, common in Southeast. Spots are purplish black, roughly circular, up to 1/3 inch across, on upper surface and irregular brown areas on underside. Mycelium is superficial in early summer, but by late summer there are subcuticular hyphae and a black shield formed over a flat cushion of fertile cells. Asci are mature and shield is fissured by spring.

Morenoella quercina (see *Lembosina quercina*). **Leaf Spot, Black Mildew** of red and black oaks; twig blight of white oak, common in Southeast.

Mycosphaerella

► Blights.

Mycosphaerella angulata. **Angular Leaf Spot** of muscadine grapes. Many small, angular black spots, more conspicuous on lower surface of leaves, which may turn yellow and die.

Mycosphaerella arachidis. **Peanut Leaf Spot**. ► *Cercospora arachidicola*.

Mycosphaerella berkeleyi. **Peanut Leaf Spot**. ► *Cercospora personata*.

Mycosphaerella (Anamorph, Pseudcercospora) **bolleana**. **Leaf Spot** of fig, and rubber-tree.

Mycosphaerella (Anamorph, Asteromella brassicae) **brassicicola**. **Ring Spot** of crucifers, chiefly cabbage and cauliflower, sometimes brussels sprouts, broccoli, and turnip. Dead spots in leaves, small to 1/2 inch, are surrounded by a green zone that keeps its color even if the rest of the leaf turns yellow. Small black pycnidia are deeply embedded in the dead tissue, often in concentric rings. In moist weather conidia ooze from pycnidia in pink tendrils. The fungus winters in old plant refuse, and ascospores are forcibly ejected from perithecia in spring. The disease is confined to the Pacific Coast and, as black blight, is serious on the seed crop in the Puget Sound area. Sanitary measures and crop rotation keep it in check.

Mycosphaerella caroliniana. **Leaf Spot, Purple Blotch** on oxydendron (sourwood). Reddish or purple spots on foliage in midsummer have dry, brown centers. Pycnidia embedded in tissue break through lower surface, spores being formed in great numbers.

Mycosphaerella caryigena. **Pecan Downy Spot**. Conidial stage has been listed as a *Pseudocercosporella caryigena*. Leaf spots are pale yellow when young, turning yellow-brown, brown, or black. Conidia produced in minute acervuli on underside of leaves form a white downy or frosty coating; leaves may drop early. Spores are spread in rain, fog, and dew. The fungus overwinters in leaves, liberating ascospores in spring to infect new foliage. Moneymaker and Stuart varieties are especially susceptible.

Control. Turn under old leaves before spring (plowing under winter cover in spring takes care of this). Spray as for scab, bordeaux mixture when leaves are half-grown and bordeaux plus 4 pounds of zinc sulfate when tips of small nuts have turned brown.

Mycosphaerella cerasella. ► *Cercospora circumscissa*.

Mycosphaerella (Anamorph, *Cercospora*) **cercidicola**. **Redbud Leaf Spot**, general. Spots are circular to angular or irregular with raised dark brown borders. With age, lesions become grayish above and rusty brown on the undersurface, with the leaf tissue yellow-green outside the borders. Spores are formed on fascicles of conidiophores projecting through stomata. The fungus winters on fallen leaves, producing perithecia in spring. Twigs may be attacked as well as foliage.

Mycosphaerella citri. **Leaf Spot or Greasy Spot** on citrus.

Mycosphaerella colorata. **Mountain-Laurel Leaf Spot**. ► *Phyllosticta kalmicola*.

Mycosphaerella (Anamorph, *Pseudocercospora cruenta*) **cruenta**. **Leaf Spot, Leaf Blotch** of soybean, and kidney bean. Leaf spots distinct to indistinct, circular to irregular, greenish to yellowish to rusty brown to almost red, sometimes with gray centers.

Mycosphaerella effigurata (Anamorph, *Piggotia fraxini*). **Ash Leaf Spot**, general east of the Plains. Spots small, purple to brown with yellow borders.

Mycosphaerella fragariae. **Strawberry Leaf Spot, Black-Seed Disease**, general on strawberries. Leaf spots are first purple then reddish with light brown or white centers, 1/8 to 1/4 inch across. Spots are also present on petioles and fruit stems, and occasionally there are black spots on fruit, with blackened achenes prominent against the white of unripe berries. Fruit

is poor; total yield is reduced; runner plants are weakened. Conidia of the *Ramularia* stage are produced in clusters of short conidiophores on underside of diseased areas; perithecia are formed in autumn at the edge of the leaf spots where the fungus winters. New conidia are produced in spring with most infection taking place through stomata. There is a difference in varietal susceptibility.

Control. Set healthy plants in well-drained soil; remove diseased leaves before planting; spray with bordeaux mixture before planting and follow with two or three more applications. The conidia are very sensitive to copper, which prevents sporulation and kills nongerminated spores.

Mycosphaerella fraxinicola (Anamorph, *Phyllosticta viridis*). **Ash Leaf Spot**, east of the Rocky Mountains.

Mycosphaerella juglandis. **Leaf Spot** of black walnut.

Mycosphaerella liriodendri (*Phyllosticta liriodendrica*). **Tulip-Tree Leaf Spot**.

Mycosphaerella louisianae. **Purple Leaf Spot** of strawberry, in the South. Large, irregular, reddish purple areas.

Mycosphaerella mori. **Mulberry Leaf Spot**, widespread, with the conidial stage reported variously as *Cercosporella, Cylindrosporium, Phloeospora, Septogloeum*, and *Septoria*. Yellow areas on upper leaf surface are matched by whitish patches underneath, the fungus forming a white downy or powdery coating. The disease is most serious in shady locations.

Mycosphaerella nigromaculans. **Black Stem Spot** of cranberry, reported from all cranberry areas, often associated with red leaf spot. The fungus enters through leaves, grows down the petioles, and forms elongated black spots on the stems, which may be completely girdled, followed by defoliation. Fruiting bodies are produced in autumn on dead stems with ascospores discharged in rainy periods in spring. The anamorph state of the fungus is a *Ramularia nigromaculans*.

Mycosphaerella nyssicola (Anamorph, *Phyllosticta nyssae*). **Tupelo Leaf Spot**, on sour gum and water tupelo. Purplish irregular blotches, an inch or more across, are scattered on upper leaf surface with lower surface dark brown. There may be heavy defoliation. Perithecia mature in spring on fallen leaves.

Mycosphaerella personata (Anamorph, *Isariopsis clavispora*). **Leaf Spot**, widespread on muscadine and other grapes after midseason. Spots are dark brown, 1/4 to 1/2 inch, surrounded by a yellow circle but with a narrow band of normal green between spot and circle.

Mycosphaerella populicola (Anamorph, *Septoria populicola*); **M. populorum** (*S. musiva*). **Leaf Spot** of native poplar; **Canker** on twigs and branches of hybrid poplars.

Mycosphaerella psilospora (Anamorph, *Septoria querceti*). **Oak Leaf Spot** on red and other oaks, common in Iowa. Spots very small, circular, with strawcolor centers and dark margins.

Mycosphaerella ribis. **Leaf Spot** of flowering currant.

Mycosphaerella ribis (*M. grossulariae*, Anamorph, *Septoria ribis*). **Leaf Spot** of gooseberry, current. Numerous small brown spots with grayish centers are formed on both sides of leaves; there may be premature defoliation. The fungus winters in leaves, producing ascospores in late spring. Two sprays of bordeaux mixture plus 1 pint of self-emulsifying cottonseed oil per 100 gallons have given good control of leaf spot on gooseberries in New York. The first application is about June 1, the second in July right after fruit is picked.

Mycosphaerella rosicola. ▶ *Cercospora rosicola*.

Mycosphaerella rubi. ▶ *Septoria rubi*.

Mycosphaerella pyri (Anamorph, *Septoria pyricola*). **Pear Leaf Spot**, also on quince, occasional on apple. Spots are small, 1/8 to 1/4 inch, grayish in center, dotted with black fruiting bodies, with a well-defined dark brown margin. There are marked differences in susceptibility in pear varieties. Flemish Beauty, Duchess, and Winter Nellis are moderately, and Kieffer very, resistant. Sprays applied for leaf blight or scab control leaf spot.

Mycocentrospora

Mycocentrospora verrucosa. **Leaf Spot** on euonymus.

Myrothecium

Deuteromycetes, Hyphomycetes

Sporodochia cushionlike, light or dark; conidiophores subhyaline to colored, repeatedly branched, bearing conidia terminally; conidia subhyaline to dark, one-celled, ovoid to elongate; weakly parasitic or saprophytic.

Myrothecium roridum. **Leaf Spot** on snapdragon, stock, eremurus, gardenia, hollyhock, aeschynanthus, aglaonema, aphelandra, dieffenbachia, epis-

cia, fittonia, nematanthus, hoya, peperomia, pilea, and sphathiphyllum. Tissues are dry, brittle, with black sporodochia. Snapdragon leaves and flowering stems wilt, with sunken cracked cankers. Avoid excessive moisture; sterilize soil.

Nematostoma

Ascomycetes, Dothideales

Nematostoma occidentalis. Leaf Hair Discoloration on Artemisa.

Neottiospora

Deuteromycetes; Coelomycetes

Pycnidia dark, smooth, innate; spores hyaline, one-celled with two to several appendages at the apex.

Alpakesa yuccifolia (formerly *Neottiospora yuccifolia*). Yucca Leaf Spot.
Neottiospora yuccifolia (see *Alpakesa yuccifolia*). Yucca Leaf Spot.

Ophiodothella

Ascomycetes, Phyllachorales

Asci in locules immersed in groups in a stroma, covered by host tissue at maturity; paraphyses lacking; spores filiform.

Ophiodothella vaccinii. Leaf Spot on huckleberry, and farkleberry.

Ovularia

Deuteromycetes, Hyphomycetes

Conidiophores emerging from leaves in clusters, simple or branched; conidia hyaline, one-celled, ovoid or globose, apical or lateral, single or sometimes catenulate; parasitic.

Ovularia aristolochiae. Leaf Spot on Dutchmans-pipe.
Ovularia pulchella (see *Ramularia pusilla*). Tan Leaf Spot on creeping bent grass.

Ramularia pusilla (formerly *Ovularia pulchella*). **Tan Leaf Spot** on creeping bent grass.

Pestalotia

▶ Blights.

Pestalotia aquatica (see *Pestalotiopsis aquatica*). **Leaf Spot** of arrow-arum.

Pestalotia aucubae. **Aucuba Leaf Spot**. The fungus appears as a weak parasite in sunscald spots or after other fungi.

Pestalotia cliftoniae. **Leaf Spot** on buckwheat-tree. Ashy or pale brown spots. Spores usually curved, constricted at septa, three setae at crest.

Pestalotia funerea (see *Pestalotiopsis funerea*). **Leaf Spot**, **Bark and Cone Spot** on conifers.

Pestalotia guepini (see *Pestalotiopsis maculans*). **Camellia Leaf Spot**, widespread.

Pestalotia leucothoës (see *Pestalotiopsis leucothoës*). **Leucothoë Leaf Spot**, apparently following winter injury or other disease.

Pestalotia macrotricha (see *Pestalotiopsis quepini* var. *macrotricha*). **Rhododendron Leaf Spot**, gray blight, twig blight, widespread on azalea and rhododendron after winter injury.

Pestalotia palmarum (see *Pestalotiopsis palmarum*). **Palm Leaf Spot**, **Gray Leaf**. **Pestalotia rhododendri** (see *Pestalotiopsis sydowiana*). **Rhododendron Leaf Spot**.

Pestalotiopsis aquatica (formerly *Pestalotia aquatica*). **Leaf Spot** of arrow-arum. Irregular, chestnut-brown spots, up to an inch in diameter, have purplish or dark borders and are wrinkled concentrically. Acervuli are sparse, black, erumpent on upper side of leaf. Spores are five-celled with three widely divergent setae.

Pestalotiopsis funerea (formerly *Pestalotia funerea*). **Leaf Spot**, **Bark and Cone Spot** on conifers. Pathogenicity of the fungus is questionable. Median spore cells are dark brown; apical hyaline cell has four or five erect setae.

Pestalotiopsis leucothoës (formerly *Pestalotia leucothoës*). **Leucothoë Leaf Spot**, apparently following winter injury or other disease.

Pestalotiopsis maculans (formerly *Pestalotia guepini*). **Camellia Leaf Spot**, widespread. Numerous, punctiform black fruiting bodies are scat-

tered over papery gray spots. The spores are five-celled, bright olivaceous, with one to four divergent, sometimes branched, setae, and a straight, short pedicel. This species seems to be a true parasite.

Pestalotiopsis palmarum (formerly *Pestalotia palmarum*). **Palm Leaf Spot**, **Gray Leaf**. Black pustules are sparsely produced on both surfaces of pale, dead areas with definite, reddish brown borders. Spores are five-celled, with two or three setae, usually knobbed. The fungus is a wound parasite.

Pestalotiopsis quepini var. **macrotricha** (formerly *Pestalotia macrotricha*). **Rhododendron Leaf Spot**, gray blight, twig blight, widespread on azalea and rhododendron after winter injury. Dark or pale spots with black raised pustules are scattered over stems and leaves. Spots are often silvery gray on upper surface and dark brown underneath, with densely gregarious acervuli sooty from dark spores.

Pestalotiopsis sydowiana (formerly *Pestalotia rhododendri*). **Rhododendron Leaf Spot**. Black pustules are scattered without order over dried brown areas of living leaves. Spores are broader than those of *P. macrotricha* and have shorter setae.

Pestalozziella

Deuteromycetes, Coelomycetes

Conidia hyaline, one-celled, with a branched appendage at apex; acervuli subcutaneous; conidophores slender, simple or branched.

Pestalozziella subsessilis. **Leaf Spot** on geranium.

Pezizella (Allophylaria)

Ascomycetes, Helotiales

Apothecia sessile, bright-colored, smooth; paraphyses filiform, blunt; spores elliptical to fusoid, hyaline, one-celled.

Discohainesia oenotherae (formerly *Pezizella* (*Discohainesia*) *oenotherae*). **Leaf Spot**, **Fruit Rot** of blackberry, raspberry, and strawberry; leaf spot of evening primrose, eugenia, galax, loosestrife, ludwigia, mock-strawberry, May-apple, peony, and sumac. Spots are irregular, gray in center with a dark

brown border. Fruiting bodies are light amber discs; spores are amber in masse.

Pezizella (Discohainesia) oenotherae (see *Discohainesia oenotherae*). **Leaf Spot**, **Fruit Rot** of blackberry, raspberry, and strawberry; leaf spot of evening primrose, eugenia, galax, loosestrife, ludwigia, mock-strawberry, May-apple, peony, and sumac.

Phacidium

► Blights.

Phacidium curtisii. **Tar Spot**, **Leaf Spot** of American holly, more serious in southern commercial plantings. Small yellow spots appearing in early summer age to reddish brown with narrow yellow borders. At end of season flat, black, cushion-shaped stromata develop beneath the epidermis. Leaves seldom drop prematurely, but infected areas may fall out leaving holes. In years of heavy rainfall berries as well as leaves are spotted. Remove lower branches; clean up and burn or turn under fallen leaves. Spray with bordeaux mixture.

Phaeosphaeria

Ascomycetes; Dothideales

Phaeosphaeria maydis. **Leaf Spot** on sweet corn.

Phaeotrichoconis

Deuteromycetes, Hyphomycetes

Phaeotrichoconis crotalariae. **Leaf Spot** on areca palm; leaf spots on palms which are similar in appearance are caused more often by *Bipolaris, Helminthosporium setariae* and *Helminthosporium (Exserohilum) rostratum*.

Phloeospora

► Blights.

Phloeospora aceris. **Leaf Spot** of maple, including vine and dwarf maples. The spot is small, rather angular, common but not important.

Phoma

► Blackleg.

Phoma sp. **Leaf Spot** on ragweed.

Phomopsis

► Blights.

Phomopsis viticola. **Leaf Spot** on grape.

Phlyctema

Deuteromycetes, Coelomycetes

Pycnidia dark, separate or sometimes confluent, in or under epidermis or bark; closed or ostiolate; conidiophores simple or forked; conidia hyaline, one-celled, cylindrical or long spindle-shaped, mostly bent, sickle-shaped; saprophytic usually.

Phlyctema ficuum. **Leaf Spot** on strangler fig.

Phyllachora

Ascomycetes, Phyllachorales

Asci in locules, immersed in groups in a dark stroma covered by host tissue at maturity; spores one-celled, hyaline; paraphyses present; asci cylindrical with short pedicels.

Phyllachora graminis. **Tar Spot**, **Black Leaf Spot**, general on wheatgrass, ryegrass, fescues, redtop, and bent grass. Elongated grayish violet to dark olive green spots, on both leaf surfaces, turn glossy black. The disease is seldom serious.

Phyllachora sylvatica. **Tar Spot** on fescues in Northwest.

Phyllosticta

► Blights.

Asterostomella saccardoi (formerly *Phyllosticta saccardoi*). **Rhododendron Leaf Spot**, similar to that caused by *P. maxima*.
Discochora philoprina (formerly *Phyllosticta ilicis* (Teleomorph, *Physalospora ilicis*)). **Holly Leaf Spot** on American and English holly and on winterberry.
Phoma exigua (formerly *Phyllosticta althaeina*). **Leaf Spot, Stem Canker** on abutilon and hollyhock. Ashy spots have black dots of pycnidia. The tissue sometimes becomes brittle and falls away, leaving jagged holes.
Phoma exigua (formerly *Phyllosticta decidua*). **Leaf Spot** of agrimony, aralia, basil weed, betony, cynoglossum, eupatorium, germander, hierachia, hoarhound, motherwort, lycopus, mint, and monarda.
Phyllosticta althaeina (see *Phoma exigua*). **Leaf Spot, Stem Canker** on abutilon and hollyhock.
Phyllosticta andropogonivora. **Leaf Spot** on bluestem (Andropogon).
Phyllosticta antirrhini. **Snapdragon Leaf Spot, Stem Rot, Blight**. Large circular, dark brown or black spots, with concentric ridges, are located most often near tips and margins of leaves; centers may be cream to pale brown, dotted with dark pycnidia. Young leaves may be curled, older leaves shrivel and hang down along the stem. Petioles are girdled with brown elongated lesions. Stems have firm brown rot with shoots or branches wilting or have ashy white spots with dark brown or purplish margins and stems cracking in area of spots. Young seedlings may damp off. Spray with bordeaux mixture; keep greenhouse cool; avoid wetting foliage in watering; clean up diseased plants.
Phyllosticta aucubae. **Aucuba Leaf Spot**. Brown or black zonate spots are mostly along margins of leaves, sometimes with much defoliation. Spores are exuded from leaves in yellow tendrils, then spread by rain, or syringing in the greenhouse.
Phyllosticta camelliae (syn. **P. camelliaecola**). **Camellia Leaf Spot**. Lesions are irregular brown spots.
Phyllosticta catalpae. **Catalpa Leaf Spot**. Dark brown or black spots 1/8 to 1/4 inch in diameter, may run together to give a blotched appearance. Minute black fruiting bodies pepper the spots, which are often associated with injury by the catalpa midge. Heavy infection may mean defoliation.

Phyllosticta circumscissa. **Leaf Spot**, widespread on apricot, peach, sour cherry, chokecherry, and garden plum.
Phyllosticta concentrica. **English Ivy Leaf Spot**, also a twig blight, widespread. Plants look ragged. Fruiting bodies are arranged in spots in concentric circles.
Phyllosticta cookei. **Magnolia Leaf Spot**. Spots are grayish without definite margins.
Phyllosticta decidua (see *Phoma exigua*). **Leaf Spot** of agrimony, aralia, basil weed, betony, cynoglossum, eupatorium, germander, hierachia, hoarhound, motherwort, lycopus, mint, and monarda.
Phyllosticta ilicis (Teleomorph, **Physalospora ilicis**) (see *Discochora philoprina*). **Holly Leaf Spot** on American and English holly and on winterberry.
Phyllosticta hamamelidis. **Witch-Hazel Leaf Spot**. Small spots enlarge to reddish brown blotches, causing some defoliation.
Phyllosticta hydrangeae. **Hydrangea Leaf Spot**, widespread. Brown spots usually near leaf margins; in severe cases both leaves and blossoms are killed. Spray with bordeaux mixture.
Phyllosticta kalmicola (Teleomorph, *Mycosphaerella colorata*). **Mountain-Laurel Leaf Spot**, **Kalmia Leaf Spot**. Circular, grayish white to silvery spots with red or purple borders, up to 1/4 inch across, are sparsely or thickly covered with black pycnidia (see Fig. 3.26). Heavy infection means disfigured foliage and some defoliation. The disease is worse in shady locations where shrubs are under drip of trees.
Phyllosticta maculicola. **Dracaena Leaf Spot**. Irregular small brown spots have yellowish margins and long coils of spores from black pycnidia.
Phyllosticta maxima. **Rhododendron Leaf Spot**, widespread. Spots are marginal or terminal, large, dark brown, and zonate.
Phyllosticta minima. **Maple Leaf Spot**, **Gray Spot**, also on boxelder, widespread. Spots are irregular, 1/4 inch or more across, with brownish centers, containing black pycnidia, and purple-brown margins. The disease is seldom serious enough for control measures.
Phyllosticta penicillariae. Leaf spot; also stunt chlorosis; on Pennisetum.
Phyllosticta richardiae. **Calla Leaf Spot**. Small, round, ash-gray spots run together, producing irregular decayed areas.
Phyllosticta saccardoi (see *Asterostomella saccardoi*). **Rhododendron Leaf Spot**, similar to that caused by *P. maxima*.
Phyllosticta sanguinariae. **Bloodroot Leaf Spot**. Spots reddish brown with a darker border, then a zone of Indian red.

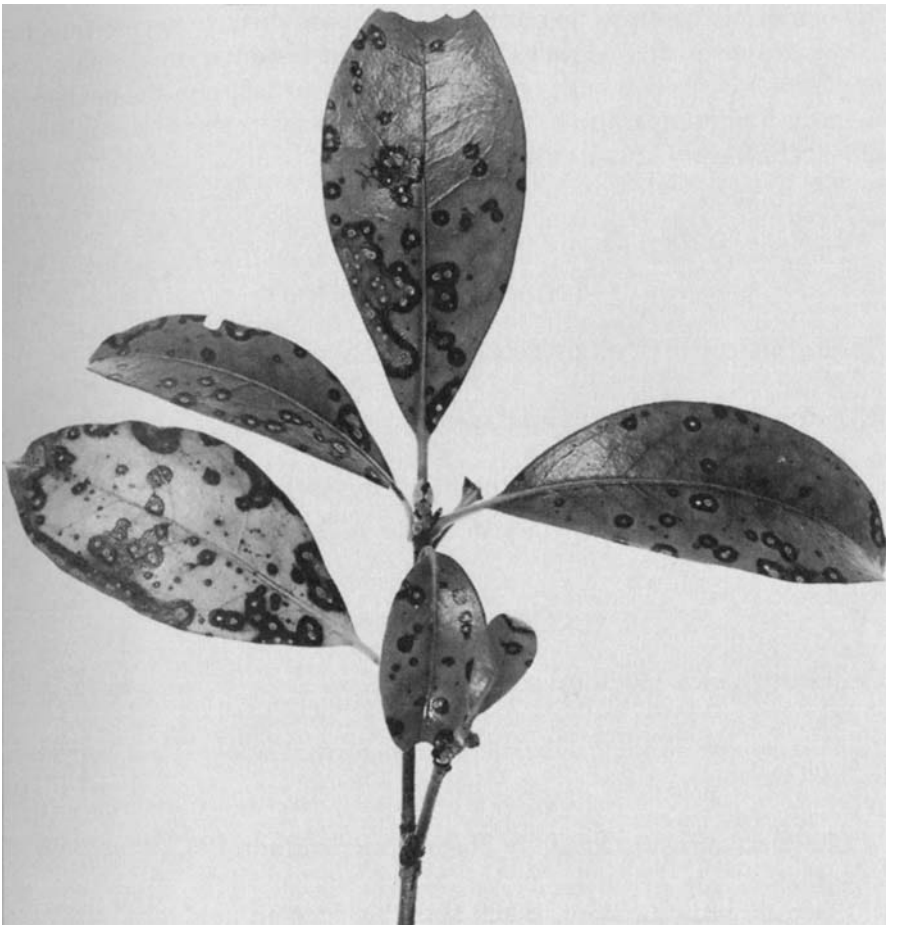

Figure 3.26 Phyllosticta Leaf Spot on Mountain-Laurel

Phyllosticta sojicola. **Leaf Spot** and **Pod Spot** of soybean; lesions have purplish red borders surrounding lighter brownish centers which contain numerous dark pycnidia (Fig. 3.26).

Phyllosticta vaccinii. **Leaf Spot** of farkleberry and highbush blueberry. Also Blueberry; Fruit Rot. Early rot, scald, blast; on cranberry. Small, circular gray spots, with one to six pycnidia in center, have brown margins. The disease is unimportant as a leaf spot; fruits have a hard, dry rot.

Phyllosticta wistariae. **Wisteria Leaf Spot**, more important in the South.

Physoderma

Chytridiomycetes, Blastocladiales

Definite mycelium with terminal and intercalary enlargements which are transformed wholly or in part into sporangia and resting spores; sporangia rare, oospores abundant, globose or ellipsoidal. Affected plant parts are discolored or slightly thickened.

Physoderma maydis. Brown Spot of corn, Corn Measles, Corn Pox, Dropsy, most prevalent in the South. Very small, bleached or yellowish spots darken to brown or reddish brown with a light margin. Adjacent spots may coalesce to give the whole blade a rusty appearance. Spots on midrib and leaf sheath are larger, up to 1/4 inch, irregular to square, darker than leaf lesions. The entire sheath may turn brown on death of host cells; the epidermis ruptures, exposing brown spore dust. In severe infections low nodes are girdled so stalks break over. The resting spores remain in soil or plant refuse over winter, germinating by swarm spores the next spring. A fairly high temperature and low, wet land favor the disease. Remove plant refuse early; rotate crops.

Phytophthora

Phytophthora ramorum. Leaf Spot (sudden oak death), California buckeye.

Tubackia (Pirostoma)

Deuteromycetes, Coelomycetes

Pycnidia superficial, with a shield; spores one-celled, dark.

Pirostoma nyssae (see *Tubackia dryira*). Tupelo Leaf Spot.
Tubackia dryina (formerly *Pirostoma nyssae*). Tupelo Leaf Spot.

Placosphaeria

Deuteromycetes, Coelomycetes

Pycnidia globose, dark, in a discoid stroma; spores hyaline, one-celled; teleomorph state in *Dothideales*.

Cheilaria agrostis (formerly *Placosphaeria graminis*). **Tar Spot** on redtop grass.
Placosphaeria graminis (see *Cheilaria agrostis*). **Tar Spot** on redtop grass.
Placosphaeria haydeni. **Black Spot**, **Tar Spot** on goldenrod and aster, stems and leaves.

Laestadia (Plagiostoma)

Ascomycetes, Diaporthales

Spores two-celled, hyaline.

Laestadia asarifolia (formerly *Plagiostoma asarifolia*). **Fruit Rot**, **Early Rot**, **Scald**, **Blast** on cranberry, also blueberry. Small, circular gray spots, with one to six pycnidia in center, have brown margins. The disease is unimportant as a leaf spot; fruits have a hard, dry rot.). **Leaf Spot** on wild ginger.
Mycosphaerella prenanthis (formerly *Plagiostoma prenanthis*). **Leaf Spot** on prenanthis.
Plagiostoma asarifolia (see *Laestadia asarifolia*). **Fruit Rot**, **Early Rot**, **Scald**, **Blast** on cranberry, also blueberry.
Plagiostoma prenanthis (see *Mycosphaerella prenanthis*). **Leaf Spot** on prenanthis.

Pleiochaeta

Pleiochaeta setosa. **Leaf Spot** on Genista

Pleospora

Ascomycetes, Dothideales

Perithecia membranous, paraphyses present; spores muriform, dark; some species have *Alternaria*, some *Stemphylium* as anamorph state; wide saprophytic and pathogenic relationships.

Pleospora herbarum (*Stemphylium botryosum; S. sarcinaeforme*). **Leaf Spot** of clovers, **Leaf Blight** of lilac, **Seed Mold** of China aster and other plants. Spots on legumes are small, irregular, dark brown, sunken, changing to concentric zonated light and dark brown areas. In final stages leaves are wrinkled, dark brown, and sooty. Conidia, like ascospores, are

muriform, olivaceous. Annual phlox has tan lesions. Asparagus has purple spots.

Pleosphaerulina (Pringsheimia)

Ascomycetes, Sphaeriales, Dothioraceae

Perithecia innate, not beaked, paraphyses and paraphysoids lacking; spores muriform, hyaline.

Pleosphaerulina sojicola (formerly *Pringsheimia sojicola*). **Leaf Spot** of soybean.

Pseudocercosporella

Pseudocercosporella capsellae. **White Leaf Spot** on mustard greens.

Pyricularia

► Blights.

Pyricularia grisea. **Leaf Spot** on grass

Ramularia

Deuteromycetes, Hyphomycetes

Conidiophores growing out from host through stoma, clustered, short, dark to hyaline; conidia hyaline, cylindrical, mostly two-celled, often in chains; found on living leaves causing leaf spots or white mold.

Cercosporella pastinaceae (formerly *Ramularia pastinaceae*). **Leaf Spot** of parsnip. Lesions are circular, very small, at first brown, then with a white center and brown border. Long, slender, septate, hyaline conidia are produced on exposed conidiophores. No control is necessary.

Entylomella armoraciae (formerly *Ramularia armoraciae*). **Pale Leaf Spot** of horseradish. Few to numerous light green to yellowish spots appear on leaves in early summer, the invaded areas quickly turning thin and papery with dead portions dropping out, leaving ragged holes late in the season.

Innumerable small sclerotium-like bodies in the dead tissue carry the fungus over winter, producing short knobby conidiophores in spring, which either push out through stomata or break through either epidermis. There is no special control.

Ramularia armoraciae (see *Entylomella armoraciae*). **Pale Leaf Spot** of horseradish

Ramularia pastinacae (see *Cercosporella pastinaceae*). **Leaf Spot** of parsnip.

Ramularia primulae. **Primrose Leaf Spot**. Yellow blotches have ash-colored centers.

Ramularia vallisumbrosae. **Narcissus White Mold**, sometimes destructive on Pacific Coast. Small, sunken, grayish or yellow spots appear on leaves, especially near tips, increasing to dark green to yellow-brown patches, on which, in moist weather, spores are formed in white powdery masses. The disease may become epidemic with the foliage killed several weeks before normal ripening. Flower stalks of late varieties may be attacked. Black "sclerotia" winter in leaf fragments on ground, producing spores in spring to infect young shoots.

Control. Spray with bordeaux mixture, starting when leaves are 4 to 6 inches high. Clean bulbs thoroughly after digging and replant in a new location.

Ramularia variabilis. **Foxglove Leaf Spot**. Irregular spots, up to 1/4 inch in diameter, brown with a reddish border, are formed most often on lower leaves. Spores in tufts give a white, moldy appearance.

Ramulispora

Deuteromycetes, Hyphomycetes

Conidia on sporodochia, two- to many-septate, hyaline to subhyaline, oblong to fusoid, irregularly united or branched at base; produced in gelatinous masses.

Ramulispora sorghi. **Copper Spot** of turf grasses, sooty stripe of sorghum, Sudan grass, and Johnson grass. Black superficial sclerotia are formed on both leaf surfaces, with conidia in pinkish gelatinous masses. Spots on leaves are straw-colored with purple borders. Dead areas in turf are small, 1 to 3 inches, copper-red to orange. Velvet bent grass in acid soil is very susceptible. Liming the soil may help.

Rhizoctonia

► Rots.

Rhizoctonia solani. **Leaf Spot** of tobacco, California pepper-tree (Schinus).

Rhytisma

Ascomycetes, Rhytismatales

Apothecia concrete with epidermis and in black, stroma-like spots, tar spots, on leaves; spores filiform, typically hyaline.

Pseudorhytisma bistortae (formerly *Rhytisma bistorti*). **Tar Spot** on polygonum. Black tarry spots similar to those on maple.
Rhytisma acerinum. **Tar Spot** of maple, especially on cut-leaf varieties. Black, thickened, raised, tarlike spots, up to 1/2 inch in diameter, are formed on upper leaf surface. They may be numerous enough to cause some defoliation but ordinarily are more disfiguring than destructive. Red and silver maples are commonly affected in the East. The lesions are light yellow-green at first, forming black stomata in summer along with the conidial stage (*Melasmia acerina*) (see Fig. 3.27). Ascospores are developed in spring in tar spots on fallen overwintered leaves and are forcibly ejected, to be carried by air currents to young leaves overhead.
Control. Collect and burn fallen leaves. Spray in early May with copper, repeating in 3 weeks in an unusually wet season.
Rhytisma andromedae. **Tar Spot** on bog rosemary and lyonia.
Rhytisma bistorti (see *Pseudorhytisma bistortae*). **Tar Spot** on polygonum.
Rhytisma liriodendri. **Leaf Spot** on tulip-tree.
Rhytisma punctatum. **Speckeled Tar Spot** of maple, a black speckled leaf spot on all species but especially on silver, striped, and bigleaf maple in Pacific Coast states, rare in the East. Black, raised specks, pinhead size, are formed in groups on upper leaf surface, in yellow-green areas about 1/2 inch in diameter. Such areas retain their color even after leaves have faded in the fall.
Rhytisma salicinum. **Tar Spot** of willow, on pussy willow and other varieties. Spots are very thick, jet black, definitely bounded, 1/4 inch in diameter. The fungus winters in old leaves which should be raked and burned.

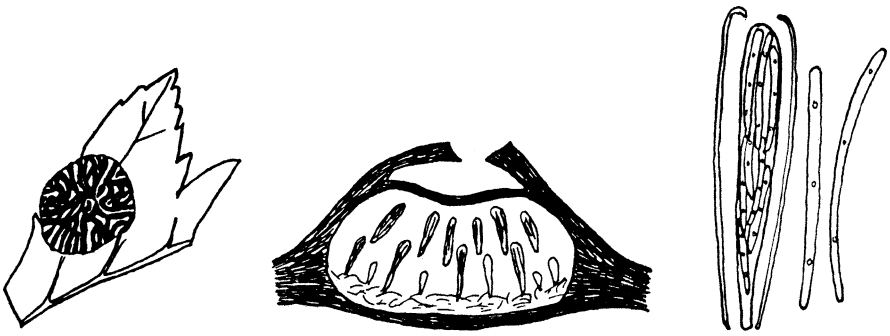

Figure 3.27 Tar Spot of Maple; black tarry spot on leaf; section through spot; ascus, paraphyses, and filiform ascospores

Schizothyrium

Ascomycetes, Dothideales

Brown scutellum or shield, radiate at margin, with a single hymenium underneath; apothecia round to linear, opening with a cleft or lobes; spores hyaline, two-celled.

Schizothyrium gaultheriae (see *Schizothyrium pomi*). **Leaf Spot** on wintergreen.
Schizothyrium pomi (formerly *Schizothyrium gaultheriae*). **Leaf Spot** on wintergreen.

Sclerotinia

► Blights.

Sclerotinia homoeocarpa. **Leaf Spot** on peanut.

Scolecotrichum

Deuteromycetes, Hyphomycetes

Conidiophores in loose clusters, simple, bearing conidia on pushed-out ends of successive new growing points; spores dark, two-celled, ovoid or oblong, often pointed; parasitic.

Cercosporidium graminis (formerly *Scolecotrichum graminis*). **Brown Stripe** of lawn grasses, **Streak** of bluegrass and redtop. Grayish brown to

dark linear streaks on leaf blade may extend into leaf sheath and cause defoliation. Dark gray masses of conidiophores emerge in rows through stomata of upper leaf surface.
Scolecotrichum graminis (see *Cercosporidium graminis*). **Brown Stripe** of lawn grasses, **Streak** of bluegrass and redtop.

Selenophoma

Deuteromycetes, Coelomycetes

Pycnidia brown, globose, immersed, erumpent, ostiolate; conidia hyaline, one-celled, bent or curved, typically crescent-shaped, parasitic.

Pseudoseptoria everhartii (formerly *Selenophoma everhartii*). **Speckle, Leaf Blotch** on bluegrass and other grasses. Brown flecks and frog-eye spots on blades in early spring enlarge to straw-colored blotches scattered with minute pycnidia. Spots may drop out, leaving holes.
Pseudoseptoria obtusa (formerly *Selenophorma obtusa*). **Speckle, Leaf Blotch** on bluegrass and other grasses. Brown flecks and frog-eye spots on blades in early spring enlarge to straw-colored blotches scattered with minute pycnidia. Spots may drop out, leaving holes.
Selenophoma donacis; Syn. **Pseudoseptoria everhartii** (formerly *S. everhartii*). **Pseudoseptoria obtusa** (formerly *S. obtusa*). **Speckle, Leaf Blotch** on bluegrass and other grasses. Brown flecks and frog-eye spots on blades in early spring enlarge to straw-colored blotches scattered with minute pycnidia. Spots may drop out, leaving holes.
Selenophoma everhartii (see *Pseudoseptoria everhartii*). **Speckle, Leaf Blotch** on bluegrass and other grasses.
Selenophoma obtusa (see *Pseudoseptoria obtusa*). **Speckle, Leaf Blotch** on bluegrass and other grasses.

Septocylindrium

Deuteromycetes, Coelomycetes

Conidiophores hyaline, short and simple or longer and branched, with irregular somewhat inflated cells; conidia hyaline, two- to several-celled, in chains that are sometimes branched; parasitic or saprophytic.

Septocylindrium hydrophylli. **Hydrophyllum Leaf Spot**.

Septogloeum

Deuteromycetes, Coelomycetes

Acervuli subepidermal, erumpent, pale; conidiophores short, simple; conidia hyaline, several-celled, oblong to fusoid; parasitic.

Diplodia acerina (formerly S*eptogloeum acerinum*). **Maple Leaf Spot**. A small leaf spot occasionally defoliating Norway and Schwedler maples in the Middle West.
Cheilaria agrostis (formerly *Septogloeum oxysporum*). **Char Spot** of lawn grasses. Lesions are tawny with yellow margins, circular becoming elliptical, pointed at each end, covered with dull black to brown stromatic tissue.
Septogloeum acerinum (see *Diplodia acerina*). **Maple Leaf Spot**.
Septogloeum oxysporum (see *Cheilaria agrostis*). **Char Spot** of lawn grasses.
Septogloeum parasiticum. **Elm Leaf Spot**, **Twig Blight**.
Septogloeum rhopaloideum (*Guignardia populi*). Grayish brown, circular or irregular spots on poplar.

Septoria

► Blights.

Septoria agropyrina. **Brown Leaf Blotch** on wheatgrasses.
Septoria bataticola. **Sweetpotato Leaf Spot**, occasional, most common in northern tier of sweetpotato states. Minute white spots on leaves are bordered with a narrow reddish zone. Older lesions have one or more pycnidia barely visible to the naked eye. The spores, oozing out in tendrils when water is present on the leaf, are spread by rain and insects. No control is needed except cleaning up crop refuse.
Septoria calamagrostidis. **Leaf Spot** on bent grasses. Scattered gray to straw-colored lesions at tip of blades, appearing in Northwest in late winter and early spring. Seaside creeping bent is especially susceptible.
Septoria callistephi. **Leaf Spot**, **Damping-off**, **Stem Rot** of China aster.
Septoria chrysanthemella and **S. obesa**. **Chrysanthemum Leaf Spot**, also on oxeye daisy, general through eastern and central states to Florida; also reported in the West. This disease is sometimes confused with nema-

tode injury, but the leaf nematode browns the leaves in wedge-shaped areas between veins, and the fungi cause definite spots. These are first small and yellowish, then dark brown to nearly black. Sometimes the spots coalesce into blotches; minute black fruiting bodies are faintly visible. Leaves may turn yellow and drop prematurely or dry and hang down along the stems. Spores are splashed from plant to plant in watering or rain, and are spread on cultivating tools.

Control. Avoid syringing greenhouse plants; do not cultivate outdoor plants, when they are wet.

Septoria citri. **Citrus Septoria Spot** on leaves but more serious on fruits. Small, shallow, light brown depressions on green immature fruit retain a green marginal ring as the fruit colors. Usually a minor trouble, sometimes important in California.

Septoria citrulli. **Watermelon Leaf Spot**. The pathogen is like *S. cucurbitacearum* except that spores are shorter. **Dogwood Leaf Spot**.

Septoria cornicola. Angular lesions between veins are grayish with dark purple margins.

Septoria cucurbitacearum. **Septoria Leaf Spot** of cucurbits, on cucumber, winter squash, muskmelon, and watermelon. Foliage spots are small, gray, circular, rather conspicuous, often bordered with a zone of yellow tissue. The fungus fruits abundantly on upper side of leaves, with long thin septate spores in black pycnidia. It winters in old plant parts; clean up all refuse at end of the season.

Septoria cyclaminis. **Leaf Spot** on cyclamen.

Septoria dianthi. **Septoria Leaf Spot** of Dianthus, on carnation and sweet william. Spots are more or less circular, light brown with purplish brown borders, scattered over leaves and stems, particularly on lower leaves. The spots may enlarge, and the leaves die. Take cuttings from disease-free plants; avoid syringing, or do it early in the day.

Septoria divaricatae (see *Septoria phlogis*). **Septoria Leaf Spot** of phlox.

Septoria gladioli. **Leaf Spot**. More important as a hard rot of gladiolus corms.

Septoria glycines. **Brown Spot** of soybean. Primarily a foliage disease, this may also appear on stems and pods. It starts with irregular brown patches on cotyledons, then reddish brown zones on both sides of leaves, often with pale green or chlorotic zones surrounding the lesions. Spots may cover the whole leaf, defoliation starting from lowest leaves. Brown discolorations with indistinct margins extend an inch or more along stems. The pathogen

winters in diseased leaves and in seed. Some varieties are quite resistant. Use healthy seed; treatment is unsatisfactory; rotate crops.

Septoria lactucae. **Septoria Leaf Spot** of lettuce, occasionally destructive to some varieties. Lesions are more common on lower leaves – irregular reddish marks, dotted sparsely with black pycnidia. The fungus is disseminated with seed.

Septoria loligena. **Leaf Spot** on ryegrass, in California. Chocolate brown spots, paler in the center, surrounded by lighter areas.

Septoria lycopersici. **Septoria Leaf Spot** of tomato, **Leaf Blight**, quite destructive in Atlantic and central states, less important in the South and West. In seasons with moderate temperature and abundant rainfall enough foliage is destroyed so that fruits do not mature properly and are subject to sunscald. The disease appears at any age but more often after fruit is set. Infection starts on older leaves near the ground, with small, thickly scattered, water-soaked spots, which become roughly circular with gray centers and prominent dark margins. The spots are smaller, 1/16 to 1/8 inch, and more numerous than those of early blight. Leaflets may die with progressive loss of foliage from the bottom up. The pathogen winters on tomato refuse and solanaceous weed hosts; spores are washed from pycnidia by rain or spread by brushing against moist leaves. Optimum temperature is 60° to 80°F.

Control. Bury plant remains deep in soil or burn; control weeds; use long rotations.

Septoria oudemansii. **Leaf Spot** of bluegrass, in northern states. Dark brown, purple spots turning straw-colored appear on leaf sheaths and spread to blades, with turf turning yellowish brown. Plants may be defoliated in cold wet seasons, but they are rarely killed.

Septoria paeoniae. **Septoria Leaf Spot** of peony, **Stem Canker**. Round gray spots with reddish borders are found on stems and leaves. Control with sanitary measures.

Septoria phlogis (formerly *Septoria divaricatae*). **Septoria Leaf Spot** of phlox. Dark brown circular spots, up to 1/4 inch in diameter, have light gray to white centers and often run together in blotches.

Septoria pistaciarum. **Leaf Spot** on pistachio.

Septoria populicola. **Leaf Spot** of poplar.

Septoria rubi. (Teleomorph, *Mycosphaerella rubi*). **Blackberry Leaf Spot** on blackberry, and dewberry, perhaps with more than one strain. See *Sphaerulina rubi* for forms reported on red raspberry. Leaf spots are

light brown, sometimes with a purple border. Infection is usually so late in the season that it is of minor importance, but it may cause some defoliation.

Septoria secalis var. **stipae**. **Leaf Spot** on bent grass. White spots turn straw-colored, with scattered pycnidia.

Septoria spraguei. **Leaf Spot** on Russian wildrye (*Elysum*).

Septoria tageticola. **Marigold Leaf Spot**, reported in 1958 from Florida. Spots are oval to irregular, smoky gray to black, speckled with minute black pycnidia. The disease advances upward from the lower leaves and also infects younger branches, peduncles, bracts, and seed. African marigolds are very susceptible, French almost immune.

Septoria tenella. **Leaf Spot** on fescue grasses. Small, vague, greasy brown spots.

Septoria tritici var. **lolicola**. **Leaf Spot** on ryegrass. Indefinite green to yellow mottled or blotched spots becoming fuscous to deep brown.

Sphaerulina

Ascomycetes, Dothideales

Perithecia separate, innate to erumpent, not beaked, lacking paraphyses and paraphysoids; hyaline, with several cells; clavate-cylindrical.

Sphaerulina rubi (Anamorph, *Cylindrosporium rubi*). **Raspberry Leaf Spot** on red and black raspberry only, common east of the Rocky Mountains. This disease and a similar one on blackberry and dewberry were for many years considered due to *Septoria rubi* and then attributed to *Mycosphaerella* as the teleomorph state. Later it was shown that two species were involved, with *Sphaerulina* the ascomycete on raspberry, *Septoria rubi* the pathogen commonly found on blackberry and dewberry.

Spots are small, circular to angular, first greenish black, then grayish; pycnidia produce elongate, three- to nine-septate spores. Perithecia, formed in fallen leaves, are black, subepidermal, later erumpent; ascospores are cylindrical, curved, pointed at both ends, usually four septate.

Sporonema

Deuteromycetes, Coelomycetes

Pycnidia dark, membranous or carbonaceous, innate, opening with torn lobes; spores hyaline, one-celled.

Sporonema camelliae. Camellia Leaf Spot.

Stemphylium

Deuteromycetes, Hyphomycetes

Conidiophores dark, mostly simple, bearing a single terminal conidium or successive conidia on new growing tips; conidia dark, muriform, smooth or spiny; parasitic or saprophytic (see Fig. 3.24).

Stemphylium sp. sp. (Teleomorph, *Pleospora herbarum*). Red Leaf Spot of gladiolus, widely distributed, causing an annual loss in Florida since 1938. Spots are small, round, translucent, pale yellow with reddish brown centers. Leaves may be killed before flowering or after spikes are cut, resulting in smaller corms. Infection takes place with 10 hours of dew or fog; rain is unnecessary; optimum temperature is 75°F. Leaves may be killed within 2 weeks of inoculation. Picardy variety is moderately susceptible; it is damaged more severely when grown near very susceptible Stoplight and Casablanca. The disease, starting on particularly susceptible varieties, spreads radially to less susceptible plants, decreasing in severity with distance from focal point. The leaf spot disappears in summer and autumn, reappears in winter 3 weeks after a cold period.
Control. Use resistant varieties to separate very susceptible types from those partly susceptible.
Stemphylium bolickii. Leaf Spot of echeveria, kalanchoë, and sedum. On some species lesions are small, raised, irregular to circular, brown to purplish black. On other species spots are larger, with tan centers, purplish margins.
Stemphylium botryosum (Teleomorph, *Pleospora herbarum*). Leaf Spot, Black Seed Rot, Seed Mold on kidney beans, pea, onion, garlic, shallot, salsify, asparagus, pepper, and tomato.
Stemphylium callistephi. Leaf Spot of China aster. Brown, nearly circular, concentrically zonate spots with dark margins on leaves, bracts, petals, and stems.
Stemphylium cucurbitacearum. Leaf Spot of cucurbits, on cucumbers, muskmelon, and winter and summer squash. The pathogen is possibly secondary, perhaps confused with *S. botryosum*. Small brown spots with lighter

centers have mycelium growing over the lesion, producing globose, multiseptate spores.

Stemphylium lycopersici. **Tomato Leaf Spot**. Similar to gray leaf spot but the conidia and conidiophores longer.

Stemphylium solani. **Gray Leaf Spot**, **Stemphylium Leaf Spot** in pepper, tomato, groundcherry, eggplant, and other *Solanum* species, mostly in the South, occasionally a problem elsewhere. In warm, humid weather, plants are defoliated in seedbed or field. First infection is on older leaves, which exhibit numerous small, dark brown spots extending through to the undersurface. Centers are often a glazed gray-brown with cracking and tearing. Leaves turn yellow and wither; all leaves may be killed except those at the top; seedbeds are often destroyed.

Control. Use clean soil for seedbed; spray seedlings at weekly intervals.

Stemphylium vesicarium, **Purple Spot** of asparagus.

Stigmatea (Stigmea)

Ascomycetes, Dothideales

Fruiting structure subcuticular, hymenium a single disclike layer covered with a scutellum; spores dark, two-celled; mycelium scanty.

Hormotheca rubicola (formerly Stigmea rubicola). **Black Spot** of raspberry. Spot formed in late summer with a membranous layer under the cuticle; fruiting bodies produced in spring.

Stigmea geranii. **Black Leaf Speck** of Geranium (cranesbill).

Stigmea rubicola (see *Hormotheca rubicola*). **Black Spot** of raspberry.

Stigmina (Stigmella)

Deuteromycetes, Hyphomycetes

Conidiophores short, dark, with a single terminal spore; conidia dark, muriform but with few cells, ovoid to oblong to nearly spherical; parasitic on leaves.

Exosporium liquidambaris (see *Stigmina liquidambaris*). **Leaf Spot** on sweet gum.

Exosporium palmivorum (see *Stigmina palmivorum*). **Leaf Spot** of palms, in greenhouses and in the South.

Stigmina liquidambaris (formerly *Exosporium liquidambaris*). **Leaf Spot** on sweet gum.

Stigmina palmivorum (formerly *Exosporium palmivorum*). **Leaf Spot** of palms, in greenhouses and in the South. Small, round, yellowish transparent spots run together to form large, irregular, gray-brown blotches; leaves may die. The disease is more serious with insufficient light. Spores are long, club-shaped, brown, with many cells. Remove and burn infected leaves. Spray with bordeaux mixture.

Stigmella platani-racemosae (see *Stigmina platani-racemosae*). **Leaf Spot** of California Sycamore, sometimes causing premature defoliation.

Stigmina platani-racemosae (formerly *Stigmella platani-racemosae*). **Leaf Spot** of California Sycamore, sometimes causing premature defoliation.

Ulocladium

Ulocladium cucurbitae. **Leaf Spot** on cucumber

LICHENS

A lichen is a fungus body, usually one of the Ascomycetes with apothecia, enclosing a green or blue-green alga. The fungus receives some food from the alga and the alga some food and protection from the fungus, a relationship termed symbiotic. Lichens frequently grow on living trees and shrubs, but their injury is indirect, an interference with light or gas exchange to stems or foliage, rather than from penetration of living cells of the suscept plant. There are three types associated with plants: crustose, a crust closely appressed to bark of main trunk or larger limbs; foliose, leaflike, prostrate but not so firmly attached to the substratum; and fructicose, bushlike, erect or hanging.

Lichens are more abundant on garden shrubs – boxwood, camellias, azaleas, and so on – and on citrus in the South. They flourish in neglected gardens and orchards, and in shady damp locations, and may sometimes kill twigs and branches of weak trees growing on poor sites.

In most gardens control is unnecessary. If lichens become too disfiguring or too abundant for plant health, they may be killed by spraying affected parts with bordeaux mixture or other copper spray; spray when the lichens are dry. They may be removed from main trunks by rubbing the bark with a steel brush after they are softened by rain.

MISTLETOE

Mistletoes are seed plants belonging to the family Viscaceae. They are semi-parasites, manufacturing food but depending on a host plant for water and mineral salts. There are three genera in North America: *Phoradendron* and *Viscum* which are true mistletoes, and *Arceuthobium*, dwarf mistletoe.

The mistletoe seed is naked embryo and endosperm invested with a fibrous coat and borne in white, straw-colored, pink, or red fruits – "berries" – embedded in a sticky gelatinous pulp enabling them to cling to bark of trees or stick to feet and beaks of birds, which disseminate them.

The seeds can germinate almost anywhere but penetrate only young thin bark, by means of a haustorium sent out from a flattened disc. Branches of the haustorium extend up and down and around the tree and occasionally produce secondary haustoria. The number of annual rings on a tree between the tip of the primary haustorium and the bark tells the age of the mistletoe. Many are 60 to 70 years old, and one has been reported as living 419 years.

The aerial portions of mistletoes are leafy, evergreen tufts of shoots on the stems of host plants, most conspicuous on hardwoods after leaf fall (see Fig. 3.28). The stems and leaves contain chlorophyll and are green but often with a yellowish, brown, or olive cast, depending on the season. All species have opposite leaves and round, jointed stems, and are dioecious with inconspicuous petal-less flowers. They occasionally become so large or numerous that the weight of the parasite breaks branches of the host. Growth is slow at first, but in 6 to 8 years the tufts may be 3 feet across. The aerial part does not live much longer than that, but the haustoria live as long as the tree, producing new bunches from adventitious buds.

Because they manufacture their own food, mistletoes require a lot of sun, which may be one reason why they flourish so in the Southwest. Leafy mistletoes are relatively harmless in some situations; in others they handicap shade and forest trees, and occasionally kill hackberries and oaks. There are a few leaf spots and other fungus diseases that keep mistletoes from getting too abundant. They are harvested for Christmas greens with a curved

Figure 3.28 Mistletoe, Common in Southern Trees

mistletoe hook, which can be used to keep aerial portions cut off valuable trees. Breaking off or cutting off the bunches, however, may lead to more shoots in an ever-widening area.

Dwarf mistletoes are far more injurious, especially to forest trees, and much less conspicuous. In western coniferous forests they rank next to heart rots in importance, reducing the quality and quantity of timber and paving the way for bark beetle infestations. Infected branches should be pruned out; if the trunk is infected, the tree should be felled and removed.

Phoradendron (True Mistletoe)

Phoradendron means tree thief. The genus is restricted to the Americas, ranging from southern New Jersey and Oregon southward. Most are on hardwoods.

Phoradendron californicum. California Mistletoe, ranging from southern California to Arizona, chiefly on Leguminosae – mesquite, carob, squawbush, creosote bush, parkinsonia. This is a leafless species, generally pendent, with long stems and reddish pink berries.

Phoradendron juniperinum. Juniper Mistletoe, a leafless species with straw- or wine-colored berries, ranging from Colorado and Utah through New Mexico and Arizona.

Phoradendron libocedri. Incense Cedar Mistletoe, confined to incense cedar and occurring throughout its range in Oregon, California, and Nevada. The pendent plants are leafless with straw-colored berries. It may injure plants severely, causing spindle-shaped swellings in limbs at point of attack and living in the trunk as a parasite for hundreds of years after external portions have disappeared.

Phoradendron serotinum (*flavescens*). Eastern Mistletoe, from southern New Jersey west to Ohio and Missouri and south to the Gulf, on many hardwoods – oaks, elm, maple, sycamore, gums, hickory, pecan, hackberry, hawthorn, persimmon, black locust, western soapberry, sassafras, and trumpet-vine. This species has white berries and is the common Christmas mistletoe.

Phoradendron tomentosum. Texas Mistletoe, abundant in Texas on elms, oaks, mesquite, osage-orange, and sugarberry; has white berries.

Phoradendron villosum. Hairy Mistletoe, ranging from Oregon through California, usually on oaks, also on Oregon myrtle, California buckeye, chestnut, and manzanitas. It has pinkish white berries and may cause large hypertrophies on oaks.

Viscum (True Mistletoe)

The genus is restricted to California. It is now known that Luther Burbank introduced the parasite into the state in about 1900. Burbank's notes indicate that seed was supplied to him by J. C. Vaughan of Chicago, Illinois. This mistletoe has spread about 3.5 miles in 75 years.

Viscum album. **European Mistletoe**, on alder, ash, birch, hawthorn, hickory, buckeye, maple, mountain ash, pear, persimmon, plum, poplar, pyracantha, willow, crabapple, and elm.

Arceuthobium (Dwarf Mistletoe)

The genus is restricted to conifers, and most species are found in the Northwest. Trees of any age may be deformed or killed, but the greatest mortality is among seedlings and saplings, with lodgepole and ponderosa pines most susceptible. The most striking symptom is the formation of witches' brooms, with sometimes the whole crown transformed into a huge broom. In other cases fusiform swellings in trunks turn into cankers. Foliage of affected trees is reduced.

The mistletoes themselves are small, rarely attaining a maximum of 8 inches, sometimes less than an inch. They are pereninal shoots, simple or branched, jointed, with leaves reduced to opposite pairs of scales at the top of each segment. Stems range in color from yellow to brown to olive green. Berries are olive green to dark blue; each contains a single seed, rarely two. The seed is ejected with force and is spread horizontally for some feet. Animals and birds account for infection at a distance.

Arceuthobium americanum. **Lodgepole Pine Dwarf Mistletoe**, common on the Rocky Mountain form but not the Pacific lodgepole pine, found also on fir; rare on other pines. The flowers bloom in spring, accessory branches forming a whorl.

Arceuthobium campylopodum. **Western Dwarf Mistletoe**. It forms witches' brooms and flowers late in summer. Widespread in Northwest principally on coastal ponderosa pine; species that were formerly called *A. campylopodum* are *A. abietinum* on white and grand firs, *A. divaricatum* on pinon pines, *A. laricis* on western larch, *A. microcarpum* on blue and Englemann spruce, *A. tsugense* on western hemlock, *A. cyanocarpum* on limber pine. Found also on exotic pines in California.

Arceuthobium cyanocarpum. **Dwarf Mistletoe** on pine, timber pine, and hemlock.

Arceuthobium douglasii. **Douglas-Fir Dwarf Mistletoe**, confined to this host. Plants are small, only 1 1/2 inches high, greenish, slender.

Arceuthobium occidentale. **Dwarf Mistletoe**, on exotic pines in California.

Arceuthobium laricis. **Dwarf Mistletoe** on fir and hemlock.

Arceuthobium pusillum. **Eastern Dwarf Mistletoe**, the only species in the East, from Minnesota to New Jersey and north to Canada, common on spruce, also on tamarack, and pines. The fruit matures in autumn; shoots are very short, less than an inch.

Arceuthobium tsugense. **Hemlock Dwarf Mistletoe** on western and mountain hemlock. *Colletotrichum gleosporioides* – a hyperparasite.

Arceuthobium vaginatum subsp. **cryptopodum**. **Southwestern Ponderosa Pine Dwarf Mistletoe**. Plant yellowish, robust.

MOLDS

The word mold, or mould, has many meanings. The first one given in Webster is "a growth, often woolly, produced on various forms of organic matter, especially when damp and decaying, by saprophytic fungi." Leaf mold is organic matter reduced to friable earth by these saprophytic fungi. When rhododendrons are fed with a fertilizer having a cottonseed meal base, one can often see a moldy growth, showing that beneficial organisms are at work breaking down the material for plant use.

Some of these saprophytic fungi have a harmful, parasitic phase. The common black bread mold, *Rhizopus nigricans*, causes soft rot of sweetpotatoes and "leak" of strawberries and grapes. *Penicillium* spp., the common blue molds on jellies, cause a decay of citrus and other fruits. Such diseases are discussed under Rots.

The word mold is used loosely to cover any profuse fungus growth on the surface of plant tissue. See Blights for a discussion of Botrytis gray mold, so common on many plants; see Leaf Spots for Alternaria brown molds and Ramularia white molds, and for moldy leaf spots due to *Heterosporium* and *Pleospora*; see Sooty Molds for the black growths on insect exudate; and see Snowmold for turf diseases.

Botryosporium

Deuteromycetes, Hyphomycetes

Conidiophores, tall, slender, hyaline producing numerous lateral branches of nearly equal length, each producing two or more secondary branches that are enlarged at the tip and bear heads of conidia; spores one-celled, hyaline; saprophytic.

Botryosporium pulchrum. **Leaf Mold** on tomato, also geranium (pelargonium), occasional in greenhouses.

Chalara (Chalaropsis)

Deuteromycetes, Hyphomycetes

Mycelium at first hyaline, then greenish; two types of conidia-macroconidia or chlamydospores, olive green, thick-walled when mature, sessile or borne in short conidiophores in compact groups; endoconidia, hyaline, formed inside end cells of a dark endoconidiophore and extruded in chains.

Chalara thielavioides (formerly *Chalaropsis thielavioides*). **Black Mold** of rose grafts. Manetti mold, usually on grafted roses, sometimes on budded roses in nursery fields. The fungus grows over and blackens cut surfaces of stock and scion, preventing union and resulting in death of scions. When outdoor roses are budded on Manetti understock, the bud often turns black and dies. Infection is only through wounds. *Rosa odorata* and *R. chinensis* var. *Manetti* are both very susceptible understocks; *R. multiflora* is moderately susceptible; Ragged Robin is immune.
Control. Use healthy understock. Spray greenhouse benches, tools, etc., with copper sulfate; prevent spread of spores by workmen on hands, clothing, and budding knife.
Chalaropsis thielavioides (formerly *Chalara thielavioides*). **Black Mold** of rose grafts.

Cladosporium

► Blotch Diseases.

Cladosporium fulvum (see *Fulvia fulva*). **Leaf Mold** of tomatoes, general on greenhouse crops, occasionally serious in gardens in wet seasons in the Southeast and sometimes present in other states.
Cladosporium herbarum. **Leaf Mold**, **Pod and Seed Spot**. The fungus is a weak parasite causing black mold of peanut, pod spot and seed mold of lima and kidney beans, glume spot of bluegrass, leaf mold of pepper and tomato, sometimes a fruit mold.
Cladosporium macrocarpum. **Black Mold** of spinach, on old leaves or secondary after other leaf spots.
Fulvia fulva (formerly *Cladosporium fulvum*). **Leaf Mold** of tomatoes, general on greenhouse crops, occasionally serious in gardens in wet seasons in the Southeast and sometimes present in other states. Diffuse, whitish spots

on upper surface of older leaves enlarge, turn yellow; the undersurface of the patches has a velvety olive brown coating of spores that are spread by air currents and in watering. Spores remain viable about the greenhouse for several months after plants are removed, and are sometimes carried on seed. Infection occurs only when humidity is high.
Control. Resistant varieties such as Globelle, Bay State, and Vetomold have been developed, but the fungus has mutated to more virulent forms. Regulating ventilators in greenhouses to reduce humidity seems to be the most practical control, sometimes providing heat on cool nights, even in summer.

Melanospora (Erostrotheca)

Ascomycetes, Melanosporales

Perithecia bright, more or less soft, without beak, paraphyses lacking; spores ellipsoid, yellow to olivaceous. Conidial stage has many spore forms.

Erostrotheca multiformis (see *Melanospora multiformis* (Anamorph, *Cladosporium album*)). **White Mold** of sweet pea, **White Blight**, also on perennial pea, observed on greenhouse crops.
Melanospora multiformis (formerly *Erostrotheca multiformis* (Anamorph, *Cladosporium album*)). **White Mold** of sweet pea, **White Blight**, also on perennial pea, observed on greenhouse crops. Leaflets are covered with tan or buff, circular to irregular, small to large spots with cinnamon brown pustules giving a granular appearance. White tufts of mold represent the *Cladosporium* stage. Pseudosclerotia are also formed in the leaves, which may die and drop. The fungus enters through stomata under conditions of high humidity. Dusting with sulfur has been suggested.

Torula

Deuteromycetes, Hyphomycetes

Conidiophores lacking; entire branches of mycelium develop into simple or branched chains of dark conidia, which separate readily; saprophytic.

Periconia maculans (formerly *Torula maculans*). **Leaf Mold** on yucca.
Torula maculans (see *Periconia maculans*). **Leaf Mold** on yucca.

NEEDLE CASTS

Certain diseases of conifers that result in conspicuous shedding of needles are termed needle casts, sometimes needle blights. Most of the fungi causing such symptoms are members of the Phacidiales.

Phaeocryptopus (Adelopus)

Ascomycetes, Dothideales

One of the black mildews, with superficial, dark mycelium; perithecia innate with a central foot, without ostiole; spores two-celled, hyaline.

Adelopus gäumannii (see *Phaeocryptopus gaeumannii*). **Adelopus Needle Cast** of Douglas-fir, **Swiss Needle Cast**.

Phaeocryptopus gaeumannii (formerly *Adelopus gäumannii*). **Adelopus Needle Cast** of Douglas-fir, **Swiss Needle Cast**. Although first noted in Switzerland in 1925, this seems to be a native American disease occurring in relatively harmless fashion on the Pacific Coast, somewhat injurious to native Douglas-fir in the Southwest and to trees in New England and New York. Needles fall prematurely, leaving only the current season's growth. If this happens for several consecutive years, trees have thin foliage, appear yellow or brown, and finally die. Needles are yellow-green to brown, often mottled, and on undersurface tiny black perithecia, issuing from stomata, appear as sooty streaks, one on each side of the middle nerve.

Bifusella

Ascomycetes, Rhytismatales

Apothecia elongate, slitting with a cleft; paraphyses lacking; spores hyaline, one-celled, club-shaped at both ends with halves joined by a narrow neck (Fig. 3.29).

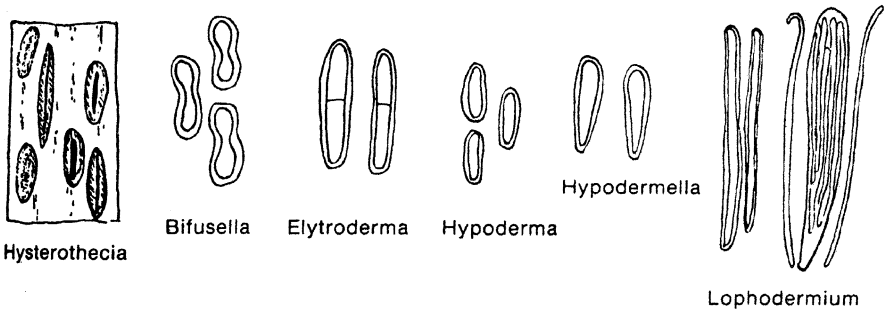

Figure 3.29 Needle Cast Fungi, which form ascospores in hysterothecia, elongate apothecia opening with a cleft. *Bifusella*, spores constricted in middle; *Elytroderma*, fusiform spores; *Hypoderma*, short fusiform spores; *Hypodermella*, spores tapering at base; *Lophodermium*, ascus with filiform spores, and paraphyses

Bifusella abietis (see *Isthmiella abietis*). **Needle Cast** of fir on alpine and corkbark fir from New Mexico to Idaho.
Bifusella faullii (see *Isthmiella faulii*). **Needle Cast** of Balsam fir, the most common and destructive of the needle casts of this host.
Bifusella linearis. **Needle Cast** of pine, **Tar Spot**, on various pine species. Hysterothecia are variable in length, shining black, on two-year needles.
Bifusella saccata. **Needle Cast** on pine.
Isthmiella abietis (formerly *Bifusella abietis*). **Needle Cast** of fir on alpine and corkbark fir from New Mexico to Idaho. Dark brown to black hysterothecia extend the entire length of the middle nerve on undersurface of needle. Pycnidia are in two rows on upper surface.
Isthmiella faulii (formerly *Bifusella faulli*). **Needle Cast** of Balsam fir, the most common and destructive of the needle casts of this host. Ascospores are discharged in July, but infected young needles do not change color until spring, then turn light brown to buff. Effused pycnidia in the same color appear in the groove on upper surface of the needle, followed by dusky brown hysterothecia (apothecia with a covering), with maturing ascospores the second summer.

Canavirgella

Canavirgella banfieldii. **Needle Cast** of pine.

Elytroderma

Ascomycetes, Rhytismatales

Ascospores two-celled, broadly fusiform (Fig. 3.29).
Elytroderma deformans. **Needle Cast**, **Witches' Broom** on Coulter, ponderosa, lodgepole, Jeffrey, pinon, and Jack pines. Elongated dull, dark hysterothecia are on both leaf surfaces. The tissues of ponderosa and Jeffrey pines may be penetrated and loose witches' brooms formed. Saplings may have entire crown converted; they die or make little growth.

Fusarium

► Blights.

Fusarium lateritium. **Needle Cast** on *Torreya taxifolia*.

Hypoderma

Ascomycetes, Rhytismatales

Hysterothecia elliptical to oblong, opening by a cleft; asci long-stalked, spores hyaline, fusiform, surrounded by a gelatinous sheath (see Fig. 3.29).
Hypoderma desmazierii (see *Meloderma desmazierii*). **Needle Cast**, **Tar Spot** of pines, most frequent on eastern white pine.
Hypoderma hedgecockii (see *Ploioderma hedgecockii*). **Needle Cast** of hard pines, in southeastern states.
Hypoderma lethali (see *Ploioderma lethale*). **Gray Blight**, **Needle Cast** of hard pines, from New England to Gulf states.
Hypoderma robustum (see *Virgella robusta*). **Needle Cast** of Firs, in West, usually white fir.
Meloderma desmazierii (formerly *Hypoderma desmazierii*). **Needle Cast**, **Tar Spot** of pines, most frequent on eastern white pine. Infected needles are at first yellow, then reddish brown, and finally deep brown with a grayish cast. The tips are infected first, the fungus being a weak parasite, completing its cycle in a year. Hysterothecia are shining black, elliptical.
Ploioderma hedgecockii (formerly *Hypoderma hedgecockii*). **Needle Cast** of hard pines, in southeastern states. Elliptical shining black hysterothecia are present in discolored areas on green needles. Each ascus contains four normal and four aborted spores.

Ploioderma lethale (formerly *Hypoderma lethaei*). **Gray Leaf Blight**, **Needle Cast** of hard pines, from New England to Gulf states. Hysterothecia are short, narrow, black, often found on pitch pine.
Virgella robusta (formerly **Hypoderma robustum**). **Needle Cast** of Firs, in West, usually white fir. Concolorous pycnidia, which form two rows, one in each needle wing, often turn black after spore discharge.

Hypodermella

Ascomycetes, Rhytismatales

Like *Bifusella* with elongate apothecia, with a cleft, but paraphyses present; spores hyaline, one-celled, club-shaped at upper end, tapering toward base (see Fig. 3.29).
Davisomycella ampla (formerly *Hypodermella ampla*). **Needle Cast** of jack pine. All needles may drop except those of the current season. Short, elliptical, dull black hysterothecia are scattered over light buff-colored areas.
Hypodermella abietis-concoloris (see *Lirula abietis-concoris*). On firs and southern balsam.
Hypodermella ampla (see *Davisomycella ampla*). **Needle Cast** of jack pine.
Hypodermella concolor (see *Lophodermella concolor*). **Needle Cast** of jack pine and lodgepole pines.
Hypodermella laricis. **Larch Needle** and **Shoot Blight** on eastern and western larches. Yellow spots are formed on needles, which turn reddish brown but stay attached, giving a scorched appearance to trees that are normally deciduous. Hysterothecia are very small, oblong to elliptical, dull black, on upper surface of needles.
Hypodermella nervata (see *Lirula nervata*). **Needle Cast** of Balsam.
Lirula abietis-concoloris (formerly *Hypodermella abietis-concoloris*). On firs and southern balsam.
Lirula nervata (formerly *Hypodermella nervata*). **Needle Cast** of Balsam. Pycnidia are in a groove along upper surface of needle in continuous or occasionally interrupted row, turning nearly black after spores are discharged.
Lophodermella concolor (formerly *Hypodermella concolor*). **Needle Cast** of jack pine and lodgepole pines. Virulent fungus infects young needles, in summer, which turn brown the next season. Short hysterothecia are concolorous with the leaf and appear as shallow depressions.

Lirula

Ascomycetes, Rhytismatales

Lirula macrospora. **Needle Cast or Blight** on spruce.

Lophodermium

► Leaf Spots.

Lirula macrospora (formerly **Lophodermium filiforme**). **Spruce Needle Cast**, sometimes causing serious defoliation of red and black spruce. Hysterothecia are long or short, shining black (see Fig. 3.29).
Lophodermium durilabrum. **Needle Cast** on pine.
Lophodermium filiforme (see *Lirula macrospora*). **Spruce Needle Cast**, sometimes causing serious defoliation of red and black spruce.
Lophodermium juniperinum. Widespread and abundant on common juniper and red-cedar but apparently not parasitic. Hysterothecia are elliptical, shining black, on both leaf surfaces.
Lophodermium nitens. Frequent but apparently saprophytic on five-needle pines. Hysterothecia short, black, shining.
Lophodermium piceae. **Needle Cast**, **Needle Blight** of fir, **Tar Spot** on fir and spruce, most severe on young specimens. Needles turn yellow, reddish, or brown, and drop. Short, shining black hysterothecia are formed on all needle surfaces.
Lophodermium pinastri. **Pine Needle Cast**, widespread. Pycnidia appear in spring or early summer as tiny black spots on browned needles, followed by dull, occasionally shining, black, short, elliptical hysterothecia. The fungus is a weak parasite but can be epidemic in nurseries. Bordeaux mixture will control it.
Lophodermium seditiosum. **Needle Cast** of scotch pine.

Mycosphaerella

► Blights.

Mycosphaerella laricina. **Needle Cast** of European larch and western larch.

Cyclaneusma (Naemacyclus)

Ascomycetes, Rhytismatales

Apothecia bright-colored, soft, opening with a cleft; paraphyses much branched; spores worm-shaped.

Cyclaneusma niveum (formerly *Naemacyclus niveus*). **Needle Cast**, occasional on various pines. Fruiting bodies tiny, elliptical, first waxy, dark brown, later concolorous with leaf surface.

Naemacyclus niveus (see *Cyclaneusma niveum*). **Needle Cast**, occasional on various pines.

Pestalotia

► Blights.

Pestalotia microspora. **Needle Spot, Cast** of Torreya.

Phoma

► Blackleg.

Phoma eupyrena. **Needle Cast and Blight** of red fir and Douglas-fir.

Rhabdocline

Ascomycetes

Apothecia innate, brown, exposed by irregular rupture of epidermis; paraphyses present; spores one-celled, becoming septate after discharge from ascus, rounded at ends and constricted in the middle.

Rhabdocline pseudotsugae. **Needle Cast** of Douglas-Fir, **Needle Blight**, common on Pacific Coast and in Rocky Mountain States on native Douglas-fir and in northeastern states on ornamental forms. The disease has reached Europe on trees from western North America and is causing much concern there.

Needles are infected in spring or early summer, with first symptoms showing as slightly yellow spots, usually at ends of needles, in autumn or winter. By

the next spring the color is reddish brown, and leaves have a mottled appearance. In severe infection needles turn a more uniform brown, and the entire tree appears scorched. Apothecia are usually on underside of needles, sometimes on upper. They are at first round cushions; then the epidermis ruptures to expose a brown, elongated disc. Infected needles drop after ascospore discharge, thereby living only 1 year instead of the normal 8 or so.

Control. Spraying with bordeaux mixture when new needles develop, repeating twice at 10- to 14-day intervals has been suggested; also, spraying with lime sulfur at time of ascospore discharge in early summer. In forests, control will probably depend on early elimination of susceptible trees.

Rhabdocline weirii. Needle Cast of Douglas-fir.

Rhizosphaera

Deuteromycetes, Sphaeropsidales, Sphaerioidaceae

Pycnidia brown, on a stalk; spores ovoid, one-celled, hyaline.

Rhizosphaera kalkhoffii. Needle Cast of blue spruce. Lowest needles are affected first, becoming mottled yellow, and the disease progresses up the tree. It has been controlled in ornamentals with three sprays of bordeaux mixture.

NEMATODES

In the six decades since the first edition of this book was prepared, nematodes have become of major importance in plant pathology. It used to be stated that plant pests, insects, and diseases, took a toll of one-tenth of all our crops. Now we believe that nematodes alone may cause a 10% crop loss, and some place the figure as high as 25%. The monetary loss is not easy to figure. Guesses range from $500,000 to $8 billion a year in the U.S. Nematodes may be as damaging in home gardens as on farms.

Nematodes used to be considered primarily a southern problem, with the root-knot nematode the major culprit. Now we know that nematodes can be as serious in Maine or Minnesota as in Florida or Texas, and that root-knot species are responsible for only a fraction of total losses.

A 1957 report from Maryland states that samples were taken from around the roots of crop plants on 1210 different farms and gardens, and that every sample included at least one species of nematode known to be a plant parasite, with root-knot nematodes making only 3.2% of the total. A 1959 report from New Jersey states that, on the basis of 2500 soil and root samples taken since 1954, a very conservative estimate of annual loss in the state is $15 million. The root-knot nematodes which are reduced by cold winters, were in third place because of their importance as pests of greenhouse crops, including African-violets, roses, and other ornamentals, as well as vegetable seedlings.

Nematodes (eelworms or roundworms) are threadlike animals in the phylum Nematoda (or Nemata). The following two references were used in the nematode taxonomic descriptions in this section:

Nickle, W. R. 1991. Manual of Agricultural Nematology. Marcel Dekker, Inc., New York, NY. 1035 pp.

Blaxter, M. L., DeLey, P., Garey, J. R., Liu, L. X., Scheldeman, P., Vierstraete, A., Vanfleteren, J. R., Mackey, L. Y., Dorris, M., Frisse, L. M., Vida, J. T., and Thomas, W. K. 1998. A molecular evolutionary framework for the phylum Nematoda. Nature 392 (6671):71–75.

Nematodes live in moist soil, water, decaying organic matter, and tissues of other living organisms. Some cause diseases of man or animals; others cause plant diseases. The animal parasites include hookworms, pinworms, and the worms in pork causing trichinosis, and they range in length from less than an inch to nearly a yard. Most plant parasites are practically microscopic in size, sometimes just barely visible to the naked eye. They mostly range from 0.5 to 2 mm long, or from 1/50 to 1/10 inch.

Nematode diseases of plants are not new. The wheat eelworm was recorded more than two centuries ago (in 1743); root knot has been a recognized problem since 1855. Our systematic investigation of plant parasitic nematodes is very new. Only in the past few years have we made surveys to find out how widespread nematodes are and how many cases of "decline" in plants are due to them. Nematodes injure plants directly by their feeding, causing cell death or gross modifications and general stunting, and indirectly by affording entrance to bacteria and fungi causing rots and wilts. Some nematodes also are vectors of ring spots and other virus diseases.

Many nematodes may merely live in the soil close to the plant and cause no damage, and a few are actually beneficial, feeding on such harmful pests as Japanese beetle grubs. Only an expert nematologist can determine species and decide which are responsible for a plant's ill health. In submitting samples to your experiment station for diagnosis, dig up roots and some surrounding soil, place immediately in a plastic bag to prevent drying out, and mail as soon as possible.

Plant parasitic nematodes may be sedentary or migratory. They do not move through soil to any great distance. Major dispersal is by shipment of infested nursery stock and soil; locally nematodes are spread on tools, and feet, in irrigation water, in plant parts, and sometimes as dry cysts by the wind. Plant nematodes are facultative or obligate parasites. They may be endoparasitic, living inside roots or other tissues, or ectoparasitic, living outside the plant, inserting only the head for feeding; and some forms are intermediate between the two types. Most plant nematodes are root parasites, but some live in stems, bulbs, leaves, or buds. Some cause galls or other distinctive symptoms; others produce a general yellowing, stunting, or dieback that is often ascribed to other causes.

Nematodes are usually long and cylindrical, tapering at both ends, round in cross section. In some genera the female is pear-shaped or saclike, but the male is always vermiform. Nematodes in general lack coloration, being

transparent or with a whitish or yellowish tint. They are covered with a cuticle, made up of three main layers,largely protein, under which is a cellular layer called the hypodermis. The body cavity, pseudocoel, is filled with fluid. The body wall musculature, directly beneath the hypodermis, consists of longitudinal fibers only. This means that nematodes cannot contract transversely. They move through moist soil with a threshing motion, or a series of undulations.

Nematodes have a complete digestive tract with a mouth at the anterior end. This is surrounded by lips bearing the sensory organs, but there is no true head, and nematodes lack eyes and nose. Basically there are six lips, but they may be fused in pairs. The sense organs, amphids, are important diagnostic characters, one class of nematodes having amphids with conspicuous openings, the other having amphids with minute pores. Most plant parasitic nematodes belong to the latter group.

Behind the mouth there is a cavity (stoma), then the esophagus, the intestine, and the rectum. The latter terminates in a ventral terminal or subterminal anus in females, in a cloacal opening in males. The sexes are usually separate, but sometimes males are missing and females are hermaphroditic. The body region behind the anus or cloacal opening is called the tail.

Near the posterior end of many nematodes there is a pair of cuticular pouches called phasmids, believed to be sense organs like the amphids. They are used to divide nematodes into two main groups, the Secernentea, or Phasmidia, with phasmids, and the Adenophorea, without phasmids.

All of the plant parasitic nematodes feed by means of a stylet, which works something like a hypodermic needle. It is a conspicuous protrusible spear used to puncture tissue. In most families this is a stomatostylet, a hollow spear derived from the sclerotized walls of the buccal cavity or stoma. Commonly the nematode punctures plant tissue with its stylet, then injects a secretion from its salivary gland that predigests the food before it is sucked in through the stylet. In the family Dorylaimidae the spear is an enlarged tooth, odontostylet, originating in the esophagus wall. It is usually hollow, but in the genus *Trichodorus* the tooth (onchiostyle) is solid but grooved.

The structure of the esophagus varies in different groups and is an important diagnostic character. The esophagus commonly has one or two swellings, known as bulbs. Those provided with a glandular apparatus are true bulbs; those lacking such apparatus are pseudobulbs. True bulbs are the chief pumping and sucking structures. They may be median, situated at midlength, or posterior, at the end of the esophagus.

Control measures for nematodes include crop rotation and other cultural practices and soil treatment with chemicals. Most chemicals are meant for fallow soil; a few are safe around living plants. Details of nematicides and their application are given in ►Chap. 1. Greenhouse soils are often steam-sterilized, and plants are sometimes dipped in hot water, the duration of the soak and the temperature depending on the tolerance of the plant and the kind of nematode to be eradicated. Some plants are antagonistic to nematodes. Asparagus roots produce a chemical that is toxic to many species, and marigolds grown with or in advance of some flower crops reduce the numbers of *Pratylenchus*, lesion nematodes. Some soil fungi trap nematodes but do not provide a practical control. The endospore-forming bacterium *Pasteuria penetrans* is known to effectively suppress certain root-knot nematodes.

Anguina

Anguinidae. Endoparasitic nematodes feeding in above ground plant tissue and transforming seeds or leaves into galls. Males and females both elongate (wormlike), but females are obese. Cuticle finely striated; stylet short with well-developed basal knobs; tail coneshaped; single ovary.

Anguina agrostis. **Grass Nematode**, serious on bent grass and chewings fescue in the Pacific Northwest. Second-stage larvae remain in sheaths near growing tips most of the year, entering embryonic flowers in late spring. There the larvae mature, and the females lay large quantities of eggs. The quickly hatching young larvae transform developing seed into elongated dark purple galls. When the galls fall to the ground, nematodes are released to reinfect grass in the vicinity. There is only one generation a year, and larvae cannot exist in moist soil more than a year without access to a host plant with developing inflorescence. The disease is important only on grass grown for seed; it is not a problem on clipped turf. When seed is threshed, galls can be carried 300 feet or more from the machines by air currents, and still further in heavy winds.

Control. Rotate with a crop other than bentgrass or fescue or plow under and prevent inflorescence for 1 year. Soak seed for 2 hours in tepid water with a wetting agent; then hold for 15 minutes at 126°F.

Anguina balsamophila. On balsam-root; galls on underside of leaves.

Anguina graminis. Galls on leaves of fescue grasses.

Anguina tritici. **Wheat Nematode** on wheat and rye, a field crop pest forming galls in place of grain. The disease was recognized in 1745, the first to be attributed to nematodes. The species is long-lived, viable nematodes having been found in seed stored 28 years. Brine flotation was the old method of eliminating galled seed.

Aphelenchoides

Aphelenchoididae. Bud and leaf nematodes, foliar nematodes. Ecto- and endoparasites; males and females wormlike, very slender; cuticle finely annulated; stylet with small basal knobs; tail with acute tip.

Aphelenchoides besseyi (including *A. oryzae*). **Summer Dwarf Nematode** of strawberry, present from Maryland to Louisiana, also reported from Oklahoma, Missouri, southern Illinois, California, and Washington. The nematodes live in the soil and are washed into buds by rains and irrigation water, affecting young leaves as they develop. Leaflets are crimped or crinkled, cupped, narrow, with a reddish cast to veins and petioles. Older leaves are darker green, more brittle than normal. This is a major disease in Florida, commonly noted from July to October. Cold weather checks its progress often masking symptoms, but plants do not recover; runner plants from infested mother plants are diseased. In spring the nematode population may be low, allowing nearly normal formation of early leaves, but in summer a single bud may harbor up to 1300 individuals, causing center leaves to be deformed and dwarfed. The same species causes a serious disease of rice in Arkansas and Louisiana.

Control. Buy certified plants; rogue and burn diseased plants as soon as noticed. Treat dormant infested plants with hot water, 2 minutes at 127°F.

Aphelenchoides fragariae (including *A. olesistus*). **Spring Dwarf Nematode** of strawberry; **Fern Nematode**, a leaf nematode. A bud parasite of strawberry from Cape Cod to Maryland and found in scattered localities along the Pacific Coast. This is a cold-weather species, persisting through the winter with several thousand nematodes present in a single bud as leaves unfold in spring. The foliage is small twisted, thickened, glossy, with swollen petioles; blossom buds are killed or poor, and no fruit is set. Some plants are killed; others recover.

As the fern nematode, or begonia leaf blight nematode, this species is recorded on anemone, aquatic plants (*Cabomba* sp., *Limnophila* sp., *Peplis* sp., and

Potamogeton sp.), begonia, bouvardia, calceolaria, chrysanthemum, clematis, coleus, crassula, dianthus, doronicum, fern, geranium, hosta, hydrangea, Lamium, lily, peony, primrose, saintpaulia, scabiosa, zinnia, and other ornamentals. Fern leaves have a patchy or blotched appearance with dark brown to black areas on the fronds. In some species these are rather narrow dark bands from midrib to border, limited by parallel side veins; in bird's-nest fern there is a profuse brown discoloration from the base halfway up the leaf.

On begonias the disease is most serious on semituberous varieties grown in greenhouses. Small brown spots with water-soaked margins, on underside of leaves, enlarge, coalesce, turn dark brown, and become visible on the upper surface. Whole leaves may turn dark; plants may be stunted. On fibrous-rooted begonias spots stay small, and leaves become shiny with a tendency to curl, lose color, and drop. Nematodes are spattered from plant to plant by syringing or careless watering; there is no disease spread when foliage is kept dry.

Dieback of Easter lilies grown in the Northwest is also attributed to this bud and leaf nematode. Leaves are first blotched with yellow, then turn brownish, drooping and curling against the stem (see Fig. 3.30). The nematodes live over in the bulbs and are splashed from leaves of one plant to another in the field. Lilies from diseased bulbs develop "bunchy-top" symptoms, with thick, twisted foliage and dieback.

Control. Strawberry plants in nurseries should be inspected and certified in spring. Mother plants, near the end of the dormant period, can be treated with hot water, 2 minutes at 127°F. Crop rotation helps.

Bulbs may be treated with hot water, for 1 hour at 111°F. Potted begonias can be submerged, pot and all, for 1 minute at 120°F, or for 3 minutes at 116°F. African violets may be treated for 30 minutes at 110°F, ferns for 10 to 15 minutes at the same temperature.

Aphelenchoides parietinus. Causing root-plate and scale necrosis of bulbous iris.

Aphelenchoides ritzemabosi. **Chrysanthemum Foliar Nematode**, common and serious on this host in home gardens and greenhouses, first reported in New Jersey in 1890. It is also recorded on dahlia, zinnia, and some other ornamentals but possibly confused with *A. fragariae*. A morphologically similar species produces a yellow bud blight of Vanda orchids. The first symptoms are dark spots on areas on underside of leaves, but by the fifth day after infestation discolored veins stand out sharply on upper leaf surface, and

Figure 3.30 Foliar Nematode on Lily

diseased leaves turn brown or black, starting in distinctive wedge-shaped areas between veins (see Fig. 3.31). Later the leaves dry, wither, and hang down along the stems. The nematodes swim from the soil up the stem in a film of water, the disease going from lowest leaves progressively upward. Almost any variety may be attacked, but Koreans are particularly susceptible. The nematodes may not survive the winter in old dead leaves but they do survive in living leaves in old crowns.

Control. Keep foliage dry; avoid overhead watering. Use a mulch to avoid splashing. Avoid crown divisions; make tip cuttings which are usually free from nematodes. Dormant plants can be treated with hot water, 5 minutes at 122°F or 30 minutes at 112°F.

Figure 3.31 Leaf Nematode of Chrysanthemum. Wormlike male and female nematodes cause wedge-shaped browning between veins, followed by general blighting of leaf

Aphelenchoides ritzemabosi. **Current Nematode**, a bud parasite on black currants and gooseberries in England; reported from California on gooseberries. Treat cuttings for 30 minutes in hot water, 110°F.
Aphelenchoides subtenuis. **Bud and Leaf Nematode** on narcissus, causing scale necrosis. Reported from the Southeast and Pacific Coast states.

Belonolaimus

Belonolaimidae. Sting nematodes, migratory obligate ectoparasites, usually found free in soil near growing tips; both sexes long, slender, with blunt ends; body strongly annulate; about 2 mm long, stylet long, with well-developed knobs; two ovaries.

Belonolaimus gracilis. **Sting Nematode** on a wide variety of hosts from Virginia southward, also reported from New Jersey and from a rose greenhouse in Connecticut. This is a major pest of strawberries, celery, and sweet corn in Florida. It injures Bermuda, centipede, and St. Augustine grasses and seedlings of slash and long-leaf pines, being first recorded from pine. Other plants damaged by *Belonolaimus* species include peanut, pea, lupine, Austrian winter pea, cowpea, bean, lima bean, soybean, beets, cabbage, cauliflower, lettuce, endive, onion, potato, and sweetpotato. The slender worms feed at root tips and along the sides. Soil fungi enter roots through feeding punctures. Roots develop short stubby branches with necrotic lesions; plants are stunted. On woody plants decline symptoms include chlorosis, twig dieback, premature dropping of fruit (such as grapefruit), and rapid wilting under moisture stress. The nematodes seem to be limited to light, sandy soils.

Control. Rotate crops; cultivate to remove weed hosts.
Belonolaimus longicaudatus. This species may be responsible for some of the injury ascribed to *B. gracilis*. It occurs in the same southeastern states and may injure roots of celery, peanut, grasses, cabbage, bean, and other vegetables. Potato and soybean are considered especially susceptible. It has also been reported on magnolia.

Bursaphelenchus

Aphelenchoididae. Ecto - and endoparasites; females (adult) have a vulval flap.

Bursaphelenchus lignicolus. Causes wilt of pine and the nematode is vectored by cerambycid beetle (pine sawyer beetle).
Bursaphelenchus xylophilus. Pinewood Nematode on pine.

Cacopaurus

Tylenchulidae. Cuticle finely annulate; female small but very obese; eggs large; male lacks stylet.

Cacopaurus pestis. Reported from roots of Persian (English) walnut in California, causing typical decline with reduction in size and number of leaves, fewer nuts, eventually complete defoliation and death.

Criconema

Criconematidae. Ring nematodes, short, thick, sedentary ectoparasites; cuticle thick with spines or scales; usually found in woodlands, in damp areas, seldom in cultivated soil.

Criconema civellae. Reported on citrus roots in a Maryland greenhouse.
Criconema decalineatum. Fig Spine Nematode on figs.
Criconema spinalineatum. Zoysia Spine Nematode on Zoysia.

Mesocriconema

Criconella xenoplax (see *Mesocriconema xenoplax*). Ring Nematode on peach cover crops including curly dock, perennial ryegrass, vetch, crimson clover, hairy vetch, and cowpea; also tall fescue, and white clover.

Mesocriconema xenoplax (formerly *Criconella xenoplax*). **Ring Nematode** on peach cover crops including curly dock, perennial ryegrass, vetch, crimson clover, hairy vetch, and cowpea; also tall fescue, and white clover.

Criconemoides (Genus dubium)

Criconematidae. Ring nematodes; short, thick-bodied; cuticle thick with retrose (inclining backward) annules; ectoparasites with a wide host range

Criconemoides annulatum. On holly oak, Montana; beans and citrus, Louisiana.
Criconemoides citri. **Citrus Ring Nematode** on citrus in Florida. The broadly annulated head is often buried deep in root tissue, which dies near the feeding puncture.
Criconemoides crotaloides. On Douglas-fir and poplar, Utah.
Criconemoides curvatum. Reported in large numbers on carnations but apparently not very injurious; also on grasses, Ohio.
Criconemoides cylindricum. On peanut, in Georgia.
Criconemoides komabaensis. On camellia, in Florida.
Criconemoides lobatum. On pines, Florida; potato, New York; also grasses.
Criconemoides mutabile. On marigold, D.C.
Criconemoides ornatum. On grasses, Ohio.
Criconemoides parvum. On grasses, Ohio.
Criconemoides rusticum. On grasses, Ohio.
Criconemoides similis. **Cobb's Ring Nematode**. Apparently an important factor in decline of peaches in Maryland and North Carolina, reported on pine in Florida and North Carolina.
Criconemoides teres. On oak, California.
Criconemoides xenoplax. On carnation, causing reduced root system, stunting, reduced flower yield; also reported on grape, peach and grasses.

Crossonema

Crossonema sp. **Decline** of Alaska cedar.

Ditylenchus

Anguinidae. Bulb and stem nematodes, slender, of moderate length, conelike tail, finely striated cuticle, mostly endoparasites.

Ditylenchus destructor. **Potato Rot Nematode**. Feeding on underground stem structures of a large number of plants but important on potato, especially in Idaho and Wisconsin. Discolored spots on tubers progress to a gray or brown decay. The tissues have a granular appearance; they dry and shrink and the skin may crack. Invasions continue in storage, sometimes with complete destruction of tubers.

Ditylenchus dipsaci. **Stem and Bulb Nematode**. An internal parasite of bulbs, stems, leaves, rarely roots, causing Eelworm Disease of Narcissus, Ring Disease of Hyacinth, Onion Bloat, Stem Disease of Phlox. The name *dipsaci* covers many strains and probably more than one species. The type was found in 1857 on Fuller's teasel. The nematodes are thought to release a pectinase during feeding, which results in a dissolution of the middle lamella and the production of large intercellular spaces. They injure, besides hyacinth and narcissus, grape-hyacinth, tulip, galtonia, garlic, shallot, and onion, and cause a stem disease of alfalfa and many flowers besides phlox.

The strains of hyacinth and narcissus are not reciprocally infective, although the hyacinth strain does infect onions. Hyacinths have yellow flecks or blotches on the leaves, which are often twisted, short, and split. In narcissus there are pustules or blisters, called spikkels, in leaves, which can be felt when the leaf is drawn through the fingers. Nematodes in such pustules probably enter leaves as they push up through the soil. Bulbs badly diseased at planting produce no foliage, or a few leaves that are premature, twisted, and bent.

When leaves are dry, nematodes are inactive; but when the foliage is moist and decayed, they revive and pass down into the soil or the neck of the bulb. They enter bulb scales, move down to the basal plate, and then enter the base of other scales. Infected scales are brown, and, since there is little lateral movement of nematodes, the cut surface of a bulb shows one or more brown rings contrasting with healthy tissue. Eggs, larvae, and adults are all present in the brown areas. Male and female adults are wormlike, up to 1.9 mm long. Infective larvae issue in large numbers in whitish tufts in a break between basal plate and scales, and work through the soil to invade adjacent plants.

They are also spread in irrigation water, on tools, and by animals. Some winter in weed hosts, some in seed of composites. In moist soil they die in a year or so, but they have been recovered from plants after 5 or 6 years.

The strain on phlox attacks campanula, sweet william, evening primrose, goldenrod, schizanthus, anemone, foxglove, and orchids. The leaves are very narrow, crinkled, and waved, often brittle, with a tendency to lengthen petioles. Stems may be swollen near the top or bent sidewise; plants are stunted, often fail to bloom, may die prematurely. The nematodes enter through stomata of young shoots and work upward as the stems develop. They infest seed of phlox and other composites, and may be so disseminated.

In onions the inner bulb scales are enlarged, causing a split onion that seldom flowers and sometimes rots at the base. Seedlings are twisted, stunted, covered with yellow spots. On plants grown from sets, a slight stunting and flaccid condition of outer leaves is followed by leaf-tip necrosis and continued stunting. The larvae may live long in infested soil and may be carried in set onions.

Control. Commercial growers routinely treat narcissus bulbs in hot water, 4 hours at 110° to 112°F. All infected plants, parts, and debris should be removed from fields and destroyed; a 2- to 4-year rotation may be tried. Take up and burn infested phlox or similar plants. Put new plants in a new location or in fumigated soil.

Ditylenchus (Sychnotylenchus) gallicus. On elm.

Ditylenchus iridis. Probably a strain of *D. dipsaci*, on bulbous iris. Mildly infected plants dry up prematurely and have poor root systems. Heavily infected plants are stunted, having few if any roots, and the bulbs decay before harvest. Treat bulbs with hot water as for narcissus, but soak only 3 hours and as soon after curing as possible.

Dolichodorus

Dolichodoriadae. Awl nematodes similar to sting nematodes with long stylet with well-developed knobs; coarsely annulated cuticle; both sexes wormlike; male tail has a bursa (lateral extension); female has two ovaries; ectoparasites.

Dolichodorus heterocephalus. **Awl Nematode**, causing decline of celery, bean, tomato, corn, pepper, and water chestnut in the Southeast, also recorded on pecan. It feeds largely on root tips and sometimes along the side of roots, causing necrotic lesions. It also feeds on germinating seeds and

hypocotyls, sometimes penetrating the seedcoat to reach the embryo. Poor seedling emergence may be due to this nematode.
Dolichodorus (Neodolichlodorus) obtusus. On arctostaphylus and pecan, California.

Dorylaimus

Dorylaimidae. Spear nematodes, with an odontostylet (hollow tooth), bottle-shaped esophagus; cuticle with longitudinal ridges; both sexes wormlike, tails rounded to cone-shaped; not proven plant parasites.

Dorylaimus spp. Found in soil near soybean, sweetpotato, and other plants but not known as a pathogen.

Helicotylenchus

Hoplolaimidae. Spiral nematodes, ectoparasites or semiendoparasites; long strong stylet with basal knobs; cuticle annulated. The head is inserted in a root, but the body remains outside in a ventrically curved spiral with one or more turns.

Helicotylenchus dihystera. On gardenia, corn, and bluegrass.
Helicotylenchus erythrinae. Zimmerman's Spiral Nematode. Rather common in Florida around roots of grasses. Present in other states on blueberry, boxwood, cauliflower, cedar, clovers, corn, cranberry, turf grasses, oak, oat, pachysandra, pepper, pieris, pine, rhubarb, soybean, strawberry, wheat, and yew.
Helicotylenchus multicinctus. Cobb's Spiral Nematode. Associated with roots of many plants, including azalea, cherry, cranberry, marsh grass, hibiscus, peach, pine, spruce, and yew.
Helicotylenchus nannus. Steiner's Spiral Nematode, a small species common in the Southeast. Found damaging roots of apple, azalea, boxwood, asparagus fern, calathea, camellia, centipede grass, civet bean, gardenia, peperomia, philodendron, rubber-plant, royal palm, laurel oak, soybean, peanut, and tomato. There is a gradual decline, stunting, and failure to form flower buds.
Helicotylenchus pseudorobustus. On corn, grape, tomato, and soybean.

Hemicriconemoides

Criconematidae. Ectoparasites; female with cuticular sheath, anchor-shaped stylet with anteriorly concave knobs; males without sheath or stylet. Commonly associated with turf and woody plants in warm climates, but pathogenicity not yet demonstrated.

Hemicriconemoides biformis. Oak Sheathoid Nematode. On roots of oak, Florida.
Hemicriconemoides chitwoodi. Associated with stunting of camellias.
Hemicriconemoides floridensis. Pine Sheathoid Nematode. On pine.
Hemicriconemoides gaddi. On camellias.
Hemicriconemoides wessoni. On myrica, Florida.

Hemicycliophora

Criconematidae. Sheath nematodes; ectoparasites with sedentary habits; female retains last molt as an extra cuticle; knobs of stylet spheroid; males rare, without stylet.

Hemicycliophora arenaria. Causing root galls on rough lemon, also reproducing in tomato, pepper, celery, squash, and bean. Celery has large, multibranched galls.
Hemicycliophora brevis. On California-laurel.
Hemicycliophora obtusa. On beet, Utah.
Hemicycliophora parvana. Tarjan's Sneath Nematode, damaging celery in Florida, also recorded on corn, beans, and dracaena.
Hemicycliophora similis. Grass Sneath Nematode. Also causes small galls on roots of blueberry and cranberry.

Heterodera and Globodera

Heteroderidae. Cyst nematodes, highly specific, attacking members of but few genera in a given plant family, partially endoparasitic, quite sedentary, attached to root by neck only. The female is lemon-shaped to globoid, white, yellow, or brown, 0.5 to 0.75 mm. Eggs are deposited or retained in body of mother, whose leathery wall forms a true cyst. Eggs remain alive for years in cysts, which are spread by wind or in soil around nonhost plants. Males are slender worms, up to 1.75 mm. Root-knot nematodes, formerly all classed as *Heterodera marioni*, have been reclassified as various species of *Meloidogyne*. The stylet *Heterodera* is twice as long as that in *Meloidogyne*, and the latter does not form true cysts.

Globodera rostochiensis (formerly *Heterodera rostochiensis*). **Golden Nematode** on white potatoes, also eggplant, tomato, and other members of the Solanaceae, but not on tobacco. It was first discovered in the United States on Long Island in 1941, and it was kept there, by a rigorous quarantine, until 1967, when it was found at a single location in upstate New York. In 1968, it was found on a potato farm in Delaware. Known as "potato sickness," the disease has been serious in the British Isles for many years. Crops do not show much damage until heavy populations have built up in the soil; then there is midday wilting, stunting, poor root development, early death, with up to 85% reduction in potato yield. The eggs live in the soil inside cysts barely visible to the naked eye. Each may contain up to 500 eggs, and some hatch one year, some another. Cysts have remained viable 17 years. In spring, when soil temperature is around 60°F, a chemical given off by potato or tomato roots stimulates hatching, and the larvae (which have had a first molt inside the egg) leave the cysts and migrate to host plants, entering the roots. The females become stationary, swell to pear shape, and break through the roots, remaining attached by a thin neck. The cylindrical males work out of the roots and cluster around to mate with the females. Eggs are formed, and the dead female becomes the cyst, first white, then gold, orange, finally brown. Cysts detached from roots remain in the soil or may be spread in potato bags, crates, machinery, even in trouser cuffs of farm workers. Lily-of-the-valley pips, cacti, and other plants intercepted at quarantine have had golden nematode cysts in fragments of soil around the roots.

Control. A quarantine restricts movement of potatoes, nursery stock, root crops and top soil from infested land. Healthy potatoes are sold in paper bags to prevent reinfestation from secondhand burlap bags. The Peconic strain of potato is said to be resistant; Rosa, Elba, and NY 71 are also resistant.

Heterodera avenae. **Oat Cyst Nematode** on pea.

Heterodera cacti. **Cactus Cyst Nematode**. Obtained from various localities in Mexico, where it is probably indigenous, and likely to occur on cacti wherever grown. The cyst is lemon-shaped.

Heterodera carotae. **Carrot Cyst Nematode**.

Heterodera cruciferae. **Cabbage Cyst Nematode**, closely related to the sugarbeet nematode. On crucifers in California. Hosts include broccoli, Brussels sprouts, cabbage, cauliflower, kale, kohlrabi, mustard, radish, rutabaga, seakale, lobularia, sweet alyssum, wallflower, and garden cress.

Heterodera fici. **Fig Cyst Nematode** on fig in Florida and California.
Heterodera glycines. **Soybean Cyst Nematode** causing Yellow Dwarf Disease. An immigrant from Japan and Korea, first noted in North Carolina in 1954, thence spread to Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Virginia. Plants are yellow, stunted; roots are small and dark with few or no bacterial nodules but with lemon-shaped brown cysts clearly visible. This nematode reproduces only in roots of lespedeza, vetch, tomato and bean, besides soybean, but the cysts occur as contaminants of narcissus bulbs and gladiolus corms grown in infested soil and may be so disseminated.
Infested areas are under federal and state quarantines. Soil fumigation temporarily reduces nematode populations and increases plant growth and yield.
Heterodera gottingiana. **Pea Cyst Nematode** on pea.
Heterodera humuli. **Hop Cyst Nematode** on bean, pea, and cucumber.
Heterodera iri. On grasses.
Heterodera mothi. **Cyst Nematode** on nutsedge.
Heterodera punctata (*Punctodera punctata*). **Grass Cyst Nematode** found on wheat and small grains, also associated with bentgrasses in North Dakota, Michigan, and Minnesota, and turfgrass in New Jersey.
Heterodera rostochiensis (see *Globodera rostochiensis*). **Golden Nematode** on white potatoes, also eggplant, tomato, and other members of the Solanaceae, but not on tobacco.
Heterodera schachtii. **Sugar Beet Nematode**, occurring in sugar-beet areas from California to Michigan, also infesting table beets and crucifers – cabbage, broccoli, rape, turnip, rutabaga, and radish. The females, numerous white specks clinging to roots, contain 100 to 600 eggs. Slender larvae puncture root cells with their strong stylets and pass through three molts inside the roots. The wormlike males then leave the roots to search for the flask-shaped females, which are attached to the roots only by their heads. Eggs are deposited in a gelatinous mass. These soon hatch to start other generations, but the females die with more eggs inside their bodies, which turn brown and become cysts. Eggs inside cysts may remain viable 5 or 6 years. Control depends on a very long crop rotation or soil fumigation.
Heterodera tabacum ((*Globodera tabacum tabacum*). **Tobacco Cyst Nematode**. Reported from Connecticut on tobacco, tomato, and other solanaceous plants, but not potato; also reported on Jerusalem-cherry, eggplant, and pepper in Virginia. Stunting is also caused on tobacco.

Heterodera trifolii. **Clover Cyst Nematode**. On clover and other legumes except peas. Spinach, beet, soybean, and carnation are minor hosts. Cysts are brown, lemon-shaped.
Heterodera zeae. **Corn Cyst Nematode**. On sweet corn, field corn, and barley.

Hoplolaimus

Hoplolamidae. Lance nematodes, somewhat migratory, some species tropical or subtropical, of moderate length; strong stylet with basal knobs; often in a spiral or C-shape position.

Hoplolaimus coronatus. On Nerine, grasses, carnation, oak, citrus, pine, sweetpotato, and tomato.
Hoplolaimus galeatus (*H. coronatus*). **Crown-Headed Lance Nematode**, wide-spread. On turf grasses, zoysia, nursery crops, corn, sugarcane, citrus, tomato, sweetpotato, pine seedlings, and carnation. This species may feed from the outside, burying the head only, or it may enter the root completely, destroying the cortex, which is sloughed off, and feeding on the phloem.
Hoplolaimus magnistylus. **Stunt** on hibiscus.
Hoplolaimus uniformis. On various ornamentals, reported from Rhode Island.

Hypsoperine

Heteroderidae. Similar to *Meloidogyne*, the root-knot nematode, but female body oval rather than pear-shaped.

Hypsoperine graminis. Described in 1964 from roots of grass and forming inconspicuous galls, primarily on members of the Gramineae. St. Augustine grass may become chlorotic and die. Bermuda grass may decline. Also present on zoysia.

Longidorus and Paralongidorus

Longidoridae. Needle nematodes; relatively large ectoparasites with long, slender stylet; similar to *Xiphinema* but not causing galls.

Longidorus elongatus. On grape, causing necrosis and excessive root-branching.
Longidorus maximus. Reported associated with celery, leek, lettuce, and parsley.
Paralongidorus sylphus. Thorn's Needle Nematode, fairly common in the Pacific Northwest, causing severe stunting of peppermint.

Meloidodera

Heteroderidae. A new genus, a link between *Heterodera* and *Meloidogyne*; eggs are retained in the female, but there is no distinct cyst stage; second stage larvae invade roots but no galls are formed.

Meloidodera floridensis. In roots of slash pine in Florida.

Meloidoderita

Tylenchulidae sp. On grapes. Males developed in soil and have a degenerate esophagus that lacks a stylet.

Meloidogyne

Heteroderidae. Root-knot nematodes, formerly considered one species, now known to be several, distinguished by slight morphological differences such as striations, perineal pattern of the tail, type of galls formed, host preferences, and somewhat by locality. Females are white, pear-shaped to sphaeroid with elongated necks, slender stylets with well-developed basal knobs; males are slender, wormlike. Females deposit eggs in a gelatinous mass, and the body is not turned into a cyst as in *Heterodera* (see Fig. 3.32).

Root knot is the best known nematode disease, with over 2000 plant species susceptible to one or more forms of Meloidogyne. Root knot was first reported in England, in 1865 on cucumbers; in 1876 it was recorded in the United States on violet. Infected plants are stunted; they often wilt, turn yellow, and die. The chief diagnostic symptom is the presence of small or large swellings or galls in the roots (see Fig. 3.33). They are nearly round or long and irregular, but they are an integral part of the root and cannot be broken off. This differentiates them from beneficial nodules, formed

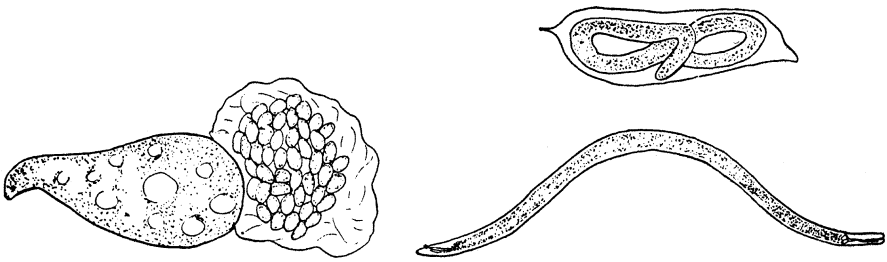

Figure 3.32 Root-Knot Nematode Galls on Potato

on legume roots by nitrogen-fixing bacteria, which can be readily broken off.

Root-knot nematodes occur in practically every state. We used to think they were killed by northern winters, but some species can survive extreme cold. They do have fewer generations in the North and do not build up such large populations as in southern sandy or peat soils. Grasses and grains are about the only plants immune or resistant to root knot.

The long, thin young larva takes form inside the egg, breaks out, and migrates through the soil to a root. It moves in to the axial cylinder and there becomes sedentary. It injects a secretion of its esophageal glands into the tissue by means of its short buccal stylet, and this stimulates the formation of 3 to 5 giant cells around the injection point. The nematode absorbs its food from these nectarial cells the rest of its life. As it feeds, the larva swells rapidly into a sausage-shaped body, which, in the female, becomes whitish and pear-shaped, large enough to be just visible to the naked eye. The male changes into a threadlike cylindrical form, folded up inside the larval molt, from which it finally escapes.

The female deposits its eggs in an extruded yellow-brown jelly. There may be up to 3000; the average is nearer 300 to 500. The larvae develop inside the eggs and become free in the soil when the host root cracks or decays. They may attack the same root in a new place or another root. At 80°F a generation takes only 25 days; at 67°F the cycle averages 87 days, and below 55°F activity ceases. Root-knot nematodes may be injurious by their feeding punctures even if typical swellings are not formed. Some have been shown to increase Fusarium and bacterial wilts, and they almost surely complicate the crown-gall problem.

Figure 3.33 Root-Knot Nematode; pear-shaped female with egg sac; encysted young larva; and wormlike adult male

Control. Rotation of crops may be practical only for species with a narrow host range, and a few varieties of vegetables, fruits, and ornamentals have been developed resistant to particular species. Soil fumigation before planting is a common control; see ►Chap. 1 for satisfactory chemicals. These usually kill larvae free in the soil but not all of those inside root knots.

Meloidogyne arenaria. **Root-Knob Nematode**. Causes stunting and root gall on dwarf gardenia, compacta holly, and japanese boxwood. Also reported on watermelon.

Meloidogyne arenaria (formerly *Meloidogyne arenaria thamesi*). **Thames' Root-Knob Nematode**. Occurring naturally in Florida, on Chinese silkplant (Boehmeria); found elsewhere in greenhouses. Also reported on tomato and scindapsus.

Meloidogyne arenaria thamesi (see *Meloidogyne arenaria*). **Thames' Root-Knob Nematode**.

Meloidogyne chitwoodi. **Columbia Root-Knob Nematode**. Has been associated with alfalfa, potato, tomato, sugar beet, wheat, and corn. This is significant because wheat and corn are commonly grown in rotation with potato and sugar beets to reduce *M. hapla*. Both monocotyledonous and dicotyledonous plant species are good hosts, indicating a wide host range for this nematode.

Meloidogyne graminicola. **Rice Root-Knob Nematode**. On purple nutsedge and yellow nutsedge. **Root-Knob Nematode** on clovers.

Meloidogyne hapla. **Northern Root-Knob Nematode**. Common on many outdoor crops in the North and in florist and nursery stock. Hosts include abelia, anoda, barberry, bean, blueberry, boxwood, California-laurel, cantaloupe, carrot, cherry, clematis, clovers, cocklebur, corn, cress, cucumber, dog fennel, eggplant, escarole, forsythia, geranium, germander, gladiolus, grape-hyacinth, goldenchain, jimsonweed, kale, lettuce, marigold, mock-orange, morning-glory, mulberry, myrtle, mustard, parsnip, pachysandra, pansy, peanut, peony, pepper, periwinkle, potato, privet, rose, sainfoin, sequoia, soybean, spirea, spurge, strawberry, sugar beet, tomato, velvetleaf, viburnum, wheat, and weigela.

This species is a particular pest of peanut and is probably the most important nematode on strawberries. It causes galls, reduces growth of main roots, resulting in excessive branch roots; plants are stunted and may die. Injury is more serious in sandy soils. Yields have been increased by using granular Nemagon, mixed with fertilizer, as a side-dressing or by planting in fumigated beds. Rotation with corn and some grains may be practical.

Meloidogyne incognita. **Root-Knob Nematode**. On kiwi, sequoia, society garlic, sweet potato, and jacquemontia.

Meloidogyne incognita. **Cotton Root-Knob Nematode**. A southern native associated with many plants – forage crops, bean, cabbage, cantaloupe, carrot, celery, chard, corn, cucumber, grape, lettuce, pepper, potato, radish, rhubarb, soybean, New Zealand spinach, squash, tobacco, tomato, turnip, watermelon; also on azalea, boxwood, camellia, calthea, coleus, collinsia, daylily, gardenia, hibiscus, hollyhock, iris, India love grass, nephthytis, roystonea, schefflera, and scindapsus. It was reported on iris in 1955, from New York and Texas, the first instance of rhizomatous iris credited as host to a root-knot nematode. Tips of leaves turn yellow, then brown, with whole leaf gradually dying. There are some resistant soybean varieties, and asparagus, strawberry, and peanut can be used in a rotation.

Meloidogyne incognita. **Southern Root-Knob Nematode**. Native to the South and common there, but overwintering as far north as New Jersey. This is the most important root-knot species on peach; it is also recorded on abelia, banana, bean, carrot, coleus, corn, cucumber, daylily, eggplant, gardenia, geranium, hibiscus, onion, okra, sweetpotato, pepper, tomato, watermelon, and willow. It causes stunting and chlorosis of gardenia, but does not occur on peanuts or strawberries, and these may be used in a rotation. Resistant crotalaria and oats can be used as cover crops in peach orchards, and some peach understocks are highly resistant.

Meloidogyne javanica. **Javanese Root-Knob Nematode**. Common in southern peach orchards and nurseries, widespread in Georgia on peaches such as Yunnan and Shali that are otherwise resistant to root knot. Found in northern greenhouses. May be associated with azalea, bean, beet, cabbage, calendula, carrot, carnation, corn, *Cocos plumosa*, cucurbits, eggplant, impatiens, radish, sequoia, snapdragon, soybean, tomato, and watermelon. Resistant peanut, strawberry, cotton, and pepper can be used in the rotation.

Meloidogyne ovalis. On maple.

Naccobus

Pratylenchidae. Males wormlike; females swollen in the middle, saclike, with a short, narrow tail; eggs extruded in a gelatinous matrix or held within the body; stylet with small basal knobs; endoparasites.

Naccobus aberrans. **False Root-Knob Nematode**. Important in western sugar-beet fields, also present on garden beets, cacti, carrot, crucifers, gaillardia, lettuce, and salsify. Root galls are similar to those caused by *Meloidogyne*, and may be fairly large.
Naccobus batatiformis. On cabbage, cactus, carrot, and stock
Naccobus dorsalis. Reported on heronsbill (erodium), probably on other hosts.

Nacobbodera

Heteroderidae
Nacobbodera chitwoodi. Reported on Douglas fir, and spruce.

Nothanguina

Anguinidae

Nothanguina (orrina) phyllobia. **Foliar Nematode**. On nightshade.

Paratylenchus

Tylenchulidae. Pin nematodes, related to ring nematodes but thinner, primarily ectoparasites; minute; cuticle finely annulated; female with long stylet, body ventrally curved but too short for a spiral.

Paratylenchus (*Gracilacus*) **anceps**. On California-laurel.
Paratylenchus dianthus. **Carnation Pin Nematode**. First reported on carnation in 1955 in Maryland, now well distributed through the Northeast.
Paratylenchus elachistus. On Boehmeria.
Paratylenchus (*Gracilacus*) **epacris**. **California Sessile Nematode**. Associated with a decline of black-walnut trees in California.
Paratylenchus hamatus. **Celery Pin Nematode**, **Fig Pin Nematode**. On azalea, bean, boxwood, celery, chrysanthemum, clover, corn, fig, geranium, gladiolus, turf grasses, hemlock, holly, horse-radish, iris, oak, onion, parsley, peach, pieris, pine, mountain-pink, prune, rose, soybean, strawberry, and tomato. This species is responsible for celery losses in New England, plants being stunted and chlorotic, and with decline of fig in California, symptoms being chlorosis and leaf drop and undersized fruit. On mint it has caused

one-third reduction in growth. The nematodes can be starved out of celery fields by a 2-year rotation with lettuce and spinach.
Paratylenchus micoletzkyi. On marigold.
Paratylenchus macrophallus. On mint.
Paratylenchus projectus. Reported from Maryland in 1955 on pasture grasses, also found on roots of alfalfa, bean, clover, corn, spruce, and soybean. A serious decline of celery and parsley in New Jersey was attributed to this species. Preplanting fumigation has produced a striking growth response.
Paratylenchus penetrans. On snapdragon.

Pratylenchus

Pratylenchidae. Lesion nematodes, sometimes called root-lesion or meadow nematodes, widely distributed migratory endoparasites; males and females wormlike, small, 0.3 to 0.9 mm, with short stylet. Conspicuous necrotic spots are formed on roots, and eggs are deposited in root tissues or in soil. Feeding punctures afford entrance to pathogenic microorganisms.

Pratylenchus brachyurus (*P. leiocephalus*). **Godfrey's Meadow Nematode**, **Smooth-Headed Meadow Nematode**. On corn, grasses, cereals, asparagus, avocado, citrus, collinsia, dogwood, peanut, pieris, pine, pineapple, potato, soybean, strawberry, and tomato. Unsightly lesions are formed on peanut shells, and the nematode survives through curing. Preplanting soil fumigation has increased yield.
Pratylenchus coffeae (*P. musicola*). Associated with strawberry black root and decline, in Arkansas.
Pratylenchus crenatus. Associated with many kinds of nursery plants.
Pratylenchus fallax. Lesion nematode on grass.
Pratylenchus hexincisus. Described from corn roots, Maryland.
Pratylenchus minyus. On pear and grape, in California. Also, on filaree.
Pratylenchus musicola. On banana, fig, olive, and walnut.
Pratylenchus nannus. Lesions nematode; On zinnia.
Pratylenchus negelectus. Lesion nematode on potato.
Pratylenchus penetrans. **Cobb's Meadow Nematode**. Associated with decline in alfalfa, amaranth, apple, arborvitae, azalea, bean, blackberry, blueberry, boxelder, cabbage, carrot, cedar, celeriac, celery, cherry, chrysanthemum, clover, corn, cucumber, eggplant, fern, garden balsam, gayfeather, gladiolus, grass, hemlock, holly, horseradish, lettuce, lily, maple, mock-

orange, onion, parsnip, peach, pear, peony, pepper, pieris, pine, mountain-pink, phlox, plum, peach, pear, potato, raspberry, rose, safflower, sequoia, soybean, spinach, spirea, strawberry, sweetpotato, tobacco, tomato, turnip, zinnia, and yarrow. This species is distributed throughout the United States. Apples have necrotic black or amber spots on white rootlets; roots may be stunted and distorted; tree vigor is reduced; leaves are small. The disease has been called "little leaf" and "rosette." The nematodes invade cortex only; secondary fungi may play a part in symptoms. Control measures include root dips and soil fumigation, hot-water treatment for strawberry stock plants, and removal of all old roots on lilies before forcing. Marigolds produce a chemical toxic to nematodes and can be used in rotations.

Pratylenchus pratensis. DeMan's Meadow Nematode. Important on grasses, strawberry, lily, and narcissus; reported on a great many other hosts, but there may have been some confusion with other species.

Pratylenchus safaenis. On soybean, corn, cotton, millet, rice, and sorghum.

Pratylenchus scribneri. Scribner's Meadow Nematode. First reported on potatoes in 1889 in Tennessee. Associated with amaryllis, hibiscus, strawberry in Florida, roses in California, and in New Jersey, clover, corn, dahlia, orchids, parsnip, peach, potato, raspberry, rose, soybean, and tomato.

Pratylenchus subpenetrans. Described from pasture grasses, Maryland.

Pratylenchus thornei. Thorn's Meadow Nematode. On wheat, other grains, and grasses. It has also been reported on maple and nectarine.

Pratylenchus vulnus. Walnut Meadow Nematode. Described in 1951 from California as an important parasite of walnut and rose on the West Coast, also present elsewhere. It may affect avocado, boxwood, almond, fig, forsythia, gayfeather, apricot, citrus, peach, plum, raspberry, loganberry, rose, sequoia, strawberry, Japanese boxwood, spiny Greek juniper, blue rug juniper, walnut, and yew. Soil fumigation has increased growth of roses by 400%.

Pratylenchus zeae. Corn Meadow Nematode. Associated with corn, also alfalfa, bean, chrysanthemum, cucumber, grasses, pea, phlox,.potato, soybean, tobacco, and tomato.

Pratylenchus spp. Lesion Nematodes. Probably as widespread as a group as root-knot nematodes and even more serious, though less readily recognized. The brown or black root condition usually comes from secondary fungi entering and rotting the roots after cells are pierced and torn by the nematodes. In boxwood and other ornamentals there is often a brush or witches' broom of new surface roots to compensate for old roots sloughed off. First

symptoms are usually yellow, black, or brown lesions on fine feeder roots. Boxwood becomes sickly, stunted; foliage is dark brown to orange, sometimes drops; some branches may be killed. Tuberous begonias may be heavily infested in roots and tubers, with poor growth. Where possible, fumigate soil before planting. Help plants to recover from root injury by mulching, adequate watering, and feeding.

Radopholus

Pratylenchidae. Burrowing nematodes; endoparasites with entire life cycle inside plants, including copulation and egg deposition. Male and female wormlike, with short stylet. Female with flat lip region, two ovaries; 0.6 mm long; male with rounded lip region.

Radopholus similis. **Burrowing Nematode**, Associated with SPREADING DECLINE OF CITRUS. The most important citrus disease in Florida. This is a subtropical species, first reported in 1893 from banana roots in the Fiji Islands. Citrus decline was known for many years before the nematode connection was made in 1953. This species is also responsible for AVOCADO DECLINE and in 1963 was reported as infesting 237 plants in many families. Possible hosts include acanthus, allamanda, aluminum plant, calathea, Barbados cherry, banana, castor-bean, cocculus, hibiscus, Japanese boxwood, Japanese persimmon, ixora, jacobinia, ginger-lily, loquat, *Momordica*, pandanus, peperomia, philodendron, periwinkle, pothos, podocarpus, palms, guava, as well as corn, pepper, tomato, and other vegetables, and various trees. Asparagus, marigold, and crotalaria are among the few nonhosts. The burrowing nematode has been found in Louisiana as well as central Florida.

The nematodes enter the cortical parenchyma of young succulent roots just back of the tip and form burrows, leaving behind avenues of infection for soil fungi and bacteria. Infected trees seldom die outright, but have poor growth and cease to produce a profitable crop. The disease spreads in all directions from an infected specimen, but somewhat unevenly, the distance ranging from 25 to 200 feet in a year, averaging about 50 feet. Long-distance spread is by transplants from nurseries.

Control. Living trees, once infected, cannot be restored to vigor. Diseased trees in quarantined areas are pulled and burned, including two trees beyond those known to be infested in an orchard, and the soil is treated with D-D. Bare-rooted nursery stock can be treated with hot water, 10 minutes at

122°F. After the "pull and treat," nonhosts are grown for 2 years before citrus is replanted. There is some hope of resistant varieties.

Rotylenchulus

Hyplolaimidae. Reniform nematodes, partially endoparasitic root parasites. Female swollen, kidney-shaped; two ovaries; male wormlike, unable to feed.

Rotylenchulus reniformis. **Reniform Nematode**. First described from pineapple roots in Hawaii, now found in Florida and other warm states on turf, cotton, peanut, sweetpotato, tomato, gardenia, jacquemontia, and other ornamentals. The head of the female, with elongated neck, goes in the cortical parenchyma of the rootlet, and her kidney-shaped body projects outside. It is covered with a gelatinous material containing eggs and larvae, so that soil particles adhere.

Rotylenchus

Hoplolaimidae. Spiral nematodes, worldwide in temperate and tropical climates; mostly ectoparasitic but partially endoparasitic, somewhat migratory; body wormlike but held in shape of a spiral; long stylet; female with two ovaries; 0.5 to 1 mm long.

Rotylenchus blaberus. **Spiral Nematode** on spider-lily.
Rotylenchus buxophilus. **Boxwood Spiral Nematode**. Associated with boxwood decline in Maryland and nearby states; also found with barberry, privet, and peony. The roots have minute brown spots, and the root system is much reduced.
Rotylenchus cristiei. On grasses.
Rotylenchus robustus. Reported on azalea.
Rotylenchus uniformis. Reported on many ornamental trees and shrubs in New Jersey nurseries.

Scutellonema

Hoplolaimidae. Spiral nematodes, similar to *Rotylenchus*.

Scutellonema blaberum (*Rotylenchus blaberus*). **West African Spiral Nematode**. On banana, yam, red spider lily, and African-violet.

Scutellonema brachyurum. Carolina Spiral Nematode. Working at crown and roots of African-violet, destroying root cells, depositing eggs in cortical tissues. Also on amaryllis.
Scutellonema bradys. Yam Nematode.
Scutellonema christiei. Christie's Spiral Nematode. Common on lawn grasses in Florida, also reported on apple and grasses in Maryland and West Virginia.

Sphaeronema

Tylenchulidae

Sphaeronema sp. sp. Decline of Alaska-cedar.

Tetylenchus

Belonolaimidae. Male and female wormlike, stylet short.

Merlinius joctus. On blueberry.

Trichodorus and Paratrichodorus

Trichodoridae. Stubby-root nematodes; migratory ectoparasites with wide host ranges; thick-bodied, cylindrical; 0.5 to 1.5 mm long; smooth cuticle; tail short, bluntly rounded; long, slender stylet is a grooved tooth.

Paratrichodorus allius. Reported reducing onion yield in Oregon.
Paratrichodorus christiei. Christie's Stubby Root Nematode. Widespread in southern states but also present elsewhere feeding on many plants in many different plant families. These include azalea, avocado, blueberry, bean, beet, cabbage, citrus, corn, cranberry, chayote, onion, potato, squash, strawberry, tomato, and turf grasses – St. Augustine, Bermuda, and zoysia. On tomato there is general stunting and formation of short lateral roots. The stubby effect is apparently caused by a secretion and not just mechanical piercing by the stylet; there is reduced cell multiplication. The host list is too long for crop rotation to be practical, and soil fumigation is not as effective as with some other species. Asparagus and poinsettia are nonhosts, and aspara-

gus has a nematicidal effect. This nematode and some other *Trichodorus* species are vectors of tobacco rattle virus, cause of potato corky ringspot.
Trichodorus obtusus. **Cobb's Stubby Root Nematode**. On Bermuda grass.
Paratrichodorus pachydermus. **Seinhorst Stubby Root Nematode**. On turf and dahlia.
Trichodorus primitivus. On azalea.

Tylenchorhynchus

Belonolaidae. Stylet nematodes, sometimes called stunt nematodes, primarily ectoparasities, somewhat migratory, common in roots of nursery stock and cultivated plants. Male and female wormlike, 0.6 to 1.7 mm long; stylet variable in length with well developed knobs; female has rounded tail, two ovaries; male tail is pointed; cuticle coarsely annulated.

Tylenchorhynchus brevidus. On grasses.
Tylenchorhynchus capitatus. Causes stunting and chlorosis of pepper, bean, tomato, and sweetpotato.
Tylenchorhynchus claytoni. **Tesselate Stylet Nematode**. Common and widespread through southeastern and eastern states. Associated with andromeda, apple, arborvitae, azalea, bean, blueberry, boxwood, broccoli, cherry, cereals, clovers, corn, cranberry, dogwood, forsythia, grape, grasses, hemlock, holly, lettuce, lilac, maple, peach, peanut, pepper, pine, potato, raspberry, rhododendron, soybean, strawberry, sweetpotato, tomato, tuliptree, veronica, willow, and yew. Azaleas may be severely injured, with reduced root system, short twigs, leaf chlorosis and increased susceptibility to winter injury. Soil treatment with the standard fumigants and also with systemics gives adequate control. Nonhosts include peanut, pepper, cucumber, and crotalaria.
Tylenchorhynchus dubius. Reported on cereals, grasses, clovers, also azalea and carnation.
Tylenchorhynchus annulatus (formerly *Tylenchorhynchus martini*). **Sugarcane Stylet Nematode**. On sugarcane, rice, soybean, and sweetpotato.
Tylenchorhynchus martini (see *Tylenchorhynchus annulatus*). **Sugarcane Stylet Nematode**. On sugarcane, rice, soybean, and sweetpotato.
Tylenchorhynchus maximus. On turf.

Tylenchulus

Tylenchulidae. Female sedentary, with elongated anterior portion entering the root and swollen, flask-shaped posterior outside the root; well-developed stylet with large basal knobs; male remains small, cylindrical; does not feed.

Tylenchulus semipenetrans. **Citrus Nematode**. First noted in California in 1912, now widespread in citrus regions; important in California and Florida, present also in Arizona and Texas. Hosts other than citrus include olive, persimmon, grape, and lilac. Citrus trees exhibit a slow decline resulting from reduced root activity. Symptoms also include twig dieback, chlorosis and dying of foliage, wilting under moisture stress, and reduced fruit production. Control measures include resistant rootstock, and hot-water treatment of nursery stock, 25 minutes at 113°F or 10 minutes at 116°F.

Tylenchus

Tylenchidae. This genus, described in 1865, originally contained most species with stomato-stylets, but many of these have been transferred to other genera. Those left are common in soil around plants but apparently not important parasites.

Xiphinema

Longidoridae. Dagger nematodes; very common migratory ectoparasites; very long, males and females both wormlike; long, slender stylet from a bottle-shaped esophagus.

Xiphinema americanum. **American Dagger Nematode**. A native, first described in 1913 from specimens taken around roots of corn, grasses, and citrus trees. Found all over the United States associated with many kinds of plants, including ash, azalea, bean, boxwood, clover, camellia, citrus, dogwood, elm, geranium, melon, oak, palm, pea, pecan, peach, pepper, pine, poplar, rose, soybean, strawberry, sweetpotato, tomato, viburnum, vinca, and walnut. In addition to its causing decline and sometimes winterkill by its feeding on roots, this species is believed to transmit tomato ringspot, peach yellow bud mosaic, and grape yellow vein viruses and to increase the incidence of Cytospora canker on spruce. Dagger nematodes may be introduced into greenhouses with virgin soil from the woods and may destroy almost all the feeder roots of plants. There may be very high soil populations.

Xiphinema bakeri. Dagger Nematode. On sequoia.
Xiphinema chambersi. Chamber's Dagger Nematode. Causing a decline in strawberries, with stunting and sunken, reddish brown root lesions.
Xiphinema diversicaudatum. European Dagger Nematode. A proven pathogen of rose, strawberry, peanut, fig, tomato, soybean, garden balsam, and other plants. This species is very common in commercial rose greenhouses, reducing vigor, causing chlorosis. Galls are formed on rose roots; they are similar to root-knot galls but more elongate and nearer the tip of the root, causing it to curl. Cleaning up a greenhouse infestation means disposal of all plants in a bed, careful sterilization of soil, and replanting with clean stock.
Xiphinema index. California Dagger Nematode. Reported on Boston ivy, grape, fig monkshood vine, pistachio, and rose. Feeding in root tips causes a terminal swelling with angling of main roots, death of lateral roots.
Xiphinema radicicola. Pacific Dagger Nematode. Reported on oak, in Florida.

NONPARASITIC DISEASES

Plants in poor health from one or more environmental conditions far outnumber those afflicted with diseases caused by parasites – bacteria, fungi, and nematodes. When foliage turns yellow from lack of nitrogen, or from unavailability of iron in an alkaline soil, or from lack of oxygen in a waterlogged soil, we call it a physiological or physiogenic or nonparasitic disease. The adverse condition may be continuing, as it is with a nutrient deficiency, or it may be transitory, an ice storm, perhaps, lasting but a day but with resultant dieback continuing for the next two years. It may be chemical injury from injudicious spraying or fertilizing or from toxic substances in the atmosphere. It may be due to a toxin injected by an insect.

Trees and crops can be insured against hail, hurricanes, lightning, and other acts of God, but not the misguided zeal of gardeners. Years of working in gardens in my own state and visiting gardens in other states from coast to coast have convinced me that plants often suffer more from their owners than from pests and diseases. Azaleas die from an overdose of aluminum sulfate applied to correct acidity, when the original cause of ill health was a too-wet soil. Rhododendron die when a deep, soggy mass of maple or other "soft" leaves is kept around the trunks. Roses die when the beds are edged with a spade and soil is mounded up in the center, burying some plants too deeply and exposing roots of others. Seedlings die from an overdose of fertilizer in hot weather. Trees die from grading operations.

Spray injury is exceedingly common, with the gardener thinking the red or brown spots are fungus leaf spots and increasing the chemical dosage until all foliage is lost. Weed killers take their unexpected toll of nearby ornamentals.

Either a deficiency or an excess of plant nutrients can cause a physiological disease. Greenhouse operators and commercial growers in the field must watch nutrition very carefully. The backyard farmer gets along pretty well by using a "complete" fertilizer containing nitrogen, phosphorus, and potassium in large amounts and minor elements in trace amounts. There are kits available for amateur diagnosticians who wish to check soil deficiencies and acidity, but you may prefer to send a soil sample to your state experiment

station for a correct interpretation of nutrients and soil acidity. Take a slice through the soil to spade or trowel depth from several places in the garden, mix those samples together, and send a small sample of the mixture.

Acidity, Excess

Soil acidity or alkalinity is measured on a pH scale that runs from 0 to 14. When the number of acid or hydrogen ions balances the number of alkaline or hydroxyl ions, we have pH 7.0 or neutral. Above pH 7.0 the soil is alkaline and may contain free lime; below it, the soil is acid. Few crop plants will grow below pH 3.5 or above pH 9.0. If the soil becomes very acid, roots are poorly developed and may decay, growth is slow, and foliage is mottled or chlorotic. This result is due either to actual excess of hydrogen ions or to physical structure of the soil and solubility of nutrients.

Most flowering plants, fruits, and vegetables do well in a soil just slightly acid, in a pH range of 6 to 7 or 6 to 8. Plants flourishing in a very acid soil, pH 4 to 5, are few: alpines, azalea, arbutus, andromeda, bunchberry, wild calla, camellia, *Chamaecyparis* (white cedar), a few ferns, wild orchids, pitcher-plants, galax, and mountain-ash. In the pH 5 to 6 list are: arbutus-tree, azalea, bleeding-heart, birch, blueberry, bent grasses, bracken, camellia, Carolina jessamine, *Clarkia*, cranberry, cypress, *Daphne odora* (but not *D. mezerium*, which is in the 6 to 8 group), hemlock, juniper, mountain-laurel, some ferns, some orchids, some oaks, pine, rhododendron, sour gum, spruce, silver-bell tree, *Styrax*, strawberry, sweetpotato, and yew.

The small kits for home testing of soils include a booklet giving the pH preferences of a long list of plants and the amount of lime required to correct the acidity. This varies with the type of soil and the original pH. To bring a sandy soil from pH 4 to above 6 takes only 1/2 pound of hydrated lime; it takes 2 pounds of lime to effect the same change in a clay soil.

Air Pollution

Polluted air is not confined to cities. Even in the country crops suffer when sunlight plus automobile exhaust produce ozone and other gases. Air pollutants come from smelters, pulp mills, factories, power plants, incinerators, and other sources. Ozone injury is common in pine, resulting in chlorotic and needle mottling, tipburn, blight, needle flecking, and stunting; in tobacco, causing “weather fleck”; in spinach, with oily areas followed by white

necrotic spots on upper leaf surface; in grape, with a dark stippling. Other sensitive plants include bean, celery, corn, tomato, carnation, orchid, radish, marigold, and petunias. Some varieties are more susceptible than others. Smog occurs from a chemical reaction of unburned hydrocarbons, as from automobiles, ozone, sunlight, and, usually, thermal inversion. Tremendous losses in California orchid houses come when smog appears when plants are in the budding stage.

Chrysanthemums may be prevented from flowering by ethylene in the atmosphere; tomatoes are also very sensitive. Injury from sulfur dioxide, a product of fuel combustion, is at a high level in the colder months. Foliage has white spots, tips, or margins. Soot particles entering houses from smokestacks cause necrotic spots.

Control. For orchids and other high-priced greenhouse crops, air can be passed through a filter of activated charcoal. Taller smokestacks reduce injury from gases and soot. Increasing the vitamin C content of plants by treating them with a substance such as potassium ascorbate may reduce injury from ozone. Installation of purification devices in automobiles and industrial plants may provide some future relief.

Alkali Injury

Some semiarid soils are nearly barren from excess of chemicals with a basic reaction. Composition varies, but three common salts are sodium chloride, sulfate of soda, and carbonate of soda; these salts become concentrated at the soil surface with a whitish incrustation. Other soils are black alkali, where the organic matter has been dissolved. Applications of gypsum or sulfur, cultivation, and mulching are correctives.

Alkalinity

Either aluminum sulfate or sulfur, or both mixed together, can be used to reduce the pH for plants doing best in a somewhat acid soil.

Aluminum Toxicity

Occasional, if aluminum is used in excess. Browning, dieback, sometimes death of azaleas and other plants may occur.

Arsenical Injury

Leaves of peaches, apricots, and other stone fruits are readily spotted or burned with lead arsenate unless lime or zinc sulfate is added as a corrective. There may be similar leaf spotting and defoliation when these tender fruits are grown in old apple land that has accumulated a residue of lead arsenate over a period of years. Even apple trees can be severely injured by arsenical sprays under some conditions.

Baldhead

In beans this is loss of the growing point, due to mechanical injury in threshing seed.

Bitter Pit

On apples this is called stippen or Baldwin spot and is characterized by small, circular, slightly sunken spots on fruit, increasing in storage, especially at warm temperatures, most frequent on varieties Jonathan, Baldwin, Spy, Rhode Island Greening. It seems to be related to fluctuation of the moisture supply in soil and increased by abundant rainfall shortly before harvest. On pear, bitter pit is sometimes associated with moisture deficiency; in olives, with overnutrition.

Black End

In pear, the whole blossom end of the fruit may turn black and dry; the disease appears when oriental pear rootstocks are used in poor soil. In walnut, black end of nuts is probably drought injury.

Black Heart

In beets, this is generally boron deficiency (see below); occasionally it is potassium or phosphorus deficiency. In apple wood it may be freezing injury; in potatoes, lack of oxygen; in celery, fluctuating soil moisture.

Black Root

Defective soil drainage and accumulation of toxins are associated with black roots, but so too are soil fungi and root nematodes.

Blasting

Blasting of influorescence and failure to produce seeds. These symptoms seem associated with extremes of soil moisture, too wet or too dry, at blossom time. Onion Blast, prevalent in the Connecticut Valley, appears within a few hours after bright sunshine follows cloudy, wet weather. Leaf tips are first white, then brown.

Blindness

Blindness of tulips and other bulbs. Failure to flower may be due to Botrytis blight or other disease, but it may come from root failure in dry soil or from heating of bulbs in storage or transit. Too early forcing may result in blindness.

Blossom-End Rot

Very common on tomatoes, also on pepper, squash, watermelon. The tissues at the blossom end of the fruit shrink, causing a dark, flattened or sunken, leathery spot, which may include nearly half the fruit (see Fig. 3.34). The disease is most common on plants that have had an excess of rainfall in the early part of the season, followed by a period of drought. There are, however, various contributing factors, the most important being a deficiency of calcium, which is needed for synthesis of rigid cell walls of the tomato. Adding calcium oxide to the soil or spraying with 1% calcium chloride has reduced the disease. For home gardens, deep soil preparation, use of a complete balanced fertilizer, and mulching to conserve moisture should help.

Bordeaux Injury

Both the copper and the lime in bordeaux mixture can be injurious to some crops. Cucurbits are stunted, and blossoming and fruit-setting are delayed in

Figure 3.34 Blossom-End Rot on Tomato

tomatoes. Red-spotting of foliage of roses and apples is followed by yellowing and defoliation. See Copper Spray Injury; Lime-Induced Chlorosis.

Boron Deficiency

A small quantity of boron is required for normal growth of most plants. For some there is not much leeway between necessary and toxic amounts; other plants require or tolerate large amounts. Deficiency symptoms vary with the crop.

Fruit trees. Internal and external cork of apples, dieback, rosette; dieback, blossom blight of pear; stunting, excessive branches, internal necrosis of peaches. Apple leaves on terminal shoots turn yellow, are convex with red veins; twigs die back from tip; dwarfed, thickened, brittle leaves are in tufts at nodes; internodes are abnormally shortened. Fruit has dry corky lesions throughout the flesh or diffuse brown lesions and bitter taste. McIntosh, Baldwin, Rome, Northwestern Greening, and Jonathan exhibit external cork with severe russeting of surface. Control by applying borax, 1 ounce per each inch of diameter of tree trunk, in a 1-foot band outside the drip of the branches. Apply only once in 3 years, and reduce the amount by half for peaches and other stone fruits and for very sandy soils.

Beets, turnips, other root crops. Black Heart, Brown Heart. Roots have dark spots; plants are gradually stunted and dwarfed; leaves are small, variegated, twisted. The interior of the beet or turnip has a dark brown to nearly black water-soaked area, sometimes with a hollow center. The amount of borax that can be added without injury depends on type of soil and moisture content.
Celery. Cracked Stem. Leaves have a brownish mottling; stems are brittle, cracked with brown stripes.
Lettuce. There is malformation of young leaves, death of growing point.
Ornamentals. Terminal flower bud dies; top leaves are thick and brittle. Application of boron in fritted form has prevented splitting in carnations, and has increased flower production in greenhouse roses.

Boron Toxicity

Retardation or prevention of germination, death or stunting of plants, bleaching or yellowing of tops, disappearance of color along midrib and veins, all are indications of excess boron. Beans are extremely sensitive to boron, with injury from as little as 4 pounds borax broadcast per acre. If borax has been used for root crops, boron-tolerant cabbage should follow before beans in the rotation.

Brown Bark Spot

Brown Bark Spot of fruit trees. Perhaps this is arsenical injury from residue in the soil.

Brown Heart

Brown Heart of turnip, cabbage, cauliflower. ► Boron Deficiency.

Bud Drop

In sweet pea very young flower buds turn yellow and drop off when there is a deficiency of phosphorus and potassium during periods of low light intensity. Water sparingly at such periods; avoid excess of nitrogen. Gardenias often drop their buds when taken from greenhouses to dry homes, but there is also bud drop in greenhouses with high soil moisture, high temperature, and lack of sunlight in winter.

Calcium Chloride Injury

Trees may be damaged when this dust-laying chemical is washed off country roads or driveways down to roots.

Calcium Deficiency

All plants require calcium, which is built into walls of cells, neutralizes harmful by-products, and maintains a balance with magnesium and potassium. Calcium is leached out of the soil as calcium carbonate and should be replaced by adding ground limestone, or dolomite (calcium magnesium carbonate), or gypsum (calcium sulfate), which does not increase the pH of the soil.

In fruits, calcium deficiency shows first in the roots, which are short and stubby with a profuse growth behind the tips that have died back. Basal immature peach leaves sometimes have reddish discolorations, and twigs may die back. Corn and legumes require large amounts of calcium, which may become unavailable under conditions of high soil acidity.

Catface

Fruit deformity, due to insects or growth disturbances.

Chlorine Injury

A tank of chlorine gas for the swimming pool carelessly opened too close to trees and shrubs causes foliage browning and sometimes death. Leaf margins are sometimes killed by chlorine gas from manufacturing processes.

Chlorosis

Yellowing or loss of normal green color may be due to deficiency of nitrogen, magnesium, or manganese. Occasionally boron deficiency or toxicity, insufficient oxygen to the roots in a waterlogged soil, or alkali injury may cause chlorosis but in the majority of cases, and particularly with broad-leaved evergreens, it occurs because iron is unavailable in an alkaline soil. ► Iron Deficiency.

Chlorosis

Hydroponically grown basil with interveinal chlorosis associated with CO_2 enrichment.

Copper Deficiency

Exanthema or dieback of fruits – apple, apricot, citrus, olive, pear, prune; failure of vegetables on muck soils. Copper deficiency in fruits is widespread in Florida and occurs frequently in California. Leaves are unusually large and dark green, or very small and quickly shed, on twigs that die back, with a reddish brown gummy discharge. Citrus fruits are bumpy and drop, or have insipid flavor and dry pulp. Application of copper sulfate to the soil corrects the deficiency, but often spraying trees once or twice in the spring with bordeaux mixture provides sufficient copper indirectly. Spraying almonds with a copper chelate has prevented shriveling of kernels. Muck or peat soils in New York, formerly unproductive, now grow normal crops of onions and lettuce with the addition of copper sulfate. On copper-deficient Florida soils, many truck crops fail to grow or are stunted, bleached, and chlorotic.

Copper Spray Injury

Some fixed copper sprays are less injurious than bordeaux mixture, but all coppers may be harmful to some plants under some conditions. Foliage spots are small, numerous, reddish, sometimes brown. In peach leaves the centers of the spots may fall out, leaving shot holes. Rosaceous plants follow spotting with yellowing and dropping of leaves. Even mild coppers may be injurious if the temperature is below 55°F, or the weather continues rainy or cloudy. Treated leaves are often harsher than normal and more subject to frost injury. Dwarfing and stunting are important symptoms on many crops, especially cucurbits. Tomato flowering is injured or delayed; apple and tomato fruits are russeted. Tree roots are injured by overflow from pools treated with copper for algae.

Cork

Boron deficiency, in apple.

Cracked Stem

Boron deficiency, in rhubarb, celery.

DDT Injury

Foliage of some plants – cucurbits particularly, roses occasionally – turns yellow or orange, often with stunting. Certain camellia varieties have been injured when shrubs are under trees sprayed with DDT. Continued spraying with DDT builds up a residue in the soil which may eventually have a toxic effect on the root system, the effect varying with the type of soil and plant.

Dieback

This is due to deficiency or excess of moisture, nutrients; winter injury; also cankers, nematodes, borers.

Drought

The effects of a prolonged dry period may be evident in trees and shrubs for two or three years thereafter.

End Spot

End Spot of avocado. Unequal maturity in both ends of the fruit seems to be a factor in withering, spotting, and cracking at lower end. Pick promptly, instead of leaving on trees.

Exanthema

Copper deficiency, in fruits.

Frost Injury

This injury is caused by low temperature after plants have started growth in spring or before they are dormant in fall (see Winter Injury for freezing

Figure 3.35 Frost Injury on Holly

during the dormant period). Yellow color of some leaves in early spring is due to temperatures unfavorable for chlorophyll formation. Some leaves, including those of rose, are reddened or crinkled with frost (Fig. 3.35). Blossom buds of fruit trees are critically injured by frost late in spring. In the South, where plants come out of dormancy early, orchard heaters, smudge fires, power fans, and airplanes flying low to stir up the air are all used to help save the crop. Many ornamentals are injured when a long, warm autumn ends in a sudden very cold snap, or warm weather in February or March is followed by heavy frosts. Cracks in tree trunks come from such temperature fluctuations.

Gas Toxicity

Illuminating gas escaping from aging gas mains causes slow decline or sudden death, depending on the plant. Tomatoes are extremely sensitive and indicate the slightest trace of gas by leaves and stems bending sharply downward. Plane trees develop "rosy canker" – long, narrow cankers near the trunk base with inner bark watermelon-pink and swollen. With large amounts of gas escaping, foliage wilts and browns suddenly, followed by death of twigs and branches; with slow leaks, the symptoms appear gradually over a year or two. After the leak is repaired, it is sometimes possible to save trees by digging a trench to aerate the roots, applying large quantities of water, burning out severely injured roots, then replacing soil and feeding to stimulate new growth.

Natural gas is, apparently, not as injurious.

Girdling Roots

Unfavorable conditions sometimes deflect roots from their normal course, and one or two may grow so closely appressed to a tree as to almost strangle it. If one side of a tree shows lighter green leaves with tendency to early defoliation, dig down on that side to see if a root is choking the trunk under the soil surface. The root should be severed and removed, then all cut surfaces painted.

Grading Injuries

Many shrubs die when they are planted much deeper than the level at which they were grown in the nursery. Similarly, many trees die when they are covered over with fill from house excavations. Roots require oxygen for survival, and a sudden excess of soil cuts off most of the supply. A tree expert should be on hand to give advice before any digging starts. Afterward is too late. And if grading means filling in soil around trees, a little well around the trunk is not enough. There must be radial and circular trenches laid with tile, and then crushed stone and gravel, before the top soil goes in place. Consult *Tree Maintenance* by P. P. Pirone for clear descriptions and diagrams for protecting trees from contractors.

Graft Incompatibility

Lilacs are sometimes blighted from incompatibility of the lilac scion on privet stock. Walnut girdle is due to incompatibility of scions on black walnut roots.

Gummosis

Formation of gum on bark of fruit trees is commonly formed in cases of bacterial canker, brown rot, crown rot, and root rots from soil fungi and in connection with the peach tree borer, but other cases of gummosis seem connected with adverse sites and soil moisture conditions irrespective of parasitic organisms.

Heart Rot

Boron deficiency, in root crops.

Heat Injury

There are many ways in which excessive high temperatures can injure plants, ranging from death to retarded growth or failure to mature flowers and fruit. Sunstroke, outright killing of plants, is a limiting factor in flower and vegetable production in summer in the South. Seedlings, especially tree seedlings and beans, may have heat cankers with stem tissues killed at the soil line. See also Sunscald, Leaf Scorch, Tipburn.

Hollow Heart

This is sometimes due to excessive soil moisture.

Hopperburn

Marginal chlorosis, burning and curling of leaves of potatoes and dahlias is due to leafhoppers.

Internal Browning or Cork

Internal Browning or Cork of apple. Boron deficiency.

Iron Deficiency

Iron is seldom, or never, actually deficient in the soil, but it is often in such an insoluble form in neutral or alkaline soils that plants cannot absorb it, or it may be precipitated as insoluble iron phosphate where excessive amounts of phosphates are added to the soil. Chlorosis is an indication of the lack of iron, for it is necessary for the formation of chlorophyll, the green pigment (see Fig. 3.36). In acid soils iron is usually available; in alkaline soils leaves turn yellowish green, often remaining green along the veins but yellowing in

Figure 3.36 Iron Deficiency in Chrysanthemum

interveinal areas. Terminal growth of twigs is small, and the shrub or tree is generally stunted.

To obtain a quick response it is possible to spray leaves with a solution of ferrous sulfate. More lasting is a soil treatment of a 50-50 mixture of ferrous sulfate and sulfur.

Rather recent is the use of chelated iron, sold as Sequestrene and under other trade names. In this form the iron cannot be combined with soil elements and remains available to the plant even under alkaline conditions. The solution, prepared according to directions on the package, is poured on the soil around the unthrifty bush, and often the green color returns in a matter of days. Iron chelates are now extensively used for citrus and for ornamentals.

Leaf Scorch

Leaf Scorch, of maple, horse-chestnut, beech, walnut, and other trees. Scattered areas in the leaf, between the veins or along the margins, turn light or dark brown, with all the leaves on a branch affected more or less uniformly. The canopy of the tree looks dry and scorched; leaves may dry and fall, with new leaves formed in summer. Lack of fruiting bodies distinguishes scorch from a fungus leaf blotch. It appears during periods of high temperature and drying winds and often after a rainy period has produced succulent growth.

Leaf scorch of Easter lilies has been a problem for years but can be prevented by keeping the pH of soil near 7.0 with lime, adequate nitrogen, but low phosphorus. It may have some connection with root rots.

Leaf scorch of iris has puzzled amateur growers in the past few years; it is more serious in the Southwest but has appeared in gardens elsewhere. Leaves turn bright reddish brown at the tips in spring before flowering, and in a few days the whole fan is scorched and withered, and the roots have rotted with a reddish discoloration (see Fig. 3.37). Many theories, including nutrition and nematodes, have been advanced, but there is no general agreement as to cause.

Lightning Injury

Trees may be completely shattered or a narrow strip of bark and a shallow layer of wood torn down the trunk. Tall trees or those growing in the open

Figure 3.37 Scorch in Iris

are most likely to be struck. Valuable trees can be protected with lightning conductors, installed by a competent tree expert.

Lime-Induced Chlorosis

Plants are sickly, with yellow foliage, in calcareous soils or near cement foundations. ► Iron Deficiency.

Little Leaf

Little Leaf, on almond, apricot, avocado and other fruits. ►Zinc Deficiency.

Magnesium Deficiency

Large areas in the Atlantic and Gulf Coast truck crop regions are low in magnesium because of natural lack of magnesium rock, extensive leaching from heavy rainfall, removal of large quantities in crops, and use of fertilizers lacking this element. In tomatoes, veins remain dark green while rest of leaf is yellow or chlorotic. Cabbages have lower leaves puckered, chlorotic, mottled, turning white at the margin and in center. In strawberries, leaves are thin, bright green, then with necrotic blotches. On fruit trees, fawn-colored patches are formed on mature, large leaves, with affected leaves dropping progressively toward the tip. In flowering plants there are a greatly reduced rate of growth, yellowing between veins of lower leaves, sometimes dead areas between veins, sometimes puckering.

Control by using dolomitic limestone, or with fertilizers containing magnesium, or with Epsom salts (magnesium sulfate) around azaleas and other shrubs in home gardens.

Manganese Deficiency

Top leaves become yellow between veins, but even smallest veins retain green color, giving a netted appearance. Lower the pH below 7 and add manganese sulfate to the soil.

Marginal Browning

Potassium deficiency or hopperburn.

Mercury Toxicity

Roses are extremely sensitive to mercury vapor and have been gravely injured when paints containing mercury were used to paint sash bars in greenhouses. Covering the paint with a paste of dry lime sulfur mixed with lime, flour, and water reduced the amount of toxic vapor.

Molybdenum Toxicity

Cause of whiptail in broccoli and cabbage, chlorosis of citrus in Florida, of grapes in Michigan. Citrus leaves have large interveinal yellow spots with gum on undersurface and may fall. Injecting the trunk with sodium molybdenate has corrected the condition quickly. On grapes chlorosis of terminal leaves was attributed to molybdenum deficiency correlated with nitrogen toxicity and was corrected by adding 0.01 ppm molybdic acid to nutrient solutions.

Mottle Leaf

Zinc deficiency.

Nitrogen Deficiency

Symptoms are paleness or uniform yellowing of leaves, and stems, firing or burning of lower leaves, sometimes red pigments along veins, stunted growth, reduced yield with small fruit. Immediate results can be obtained by side-dressing with a quickly available nitrogenous fertilizer, but long-range planning includes use of legumes in the rotation, green-manure crops, and balanced fertilizers. Urea is recommended for turf, one application providing a slow release through the season.

Nitrogen Excess

Too much nitrogen leads to overdevelopment of vegetative growth at the expense of flowers and fruit; to bud drop of roses, sweet peas, and tomatoes; and, in high concentrations, to stunting, chlorosis, and death. Excessive nitrogen decreases resistance to winter injury and to such diseases as fire blight, powdery mildew, and apple scab.

Oedema

Small, wartlike, sometimes corky, excrescences are formed on underside of leaves of many plants – cabbage, tomatoes, geraniums, begonia, camellias,

etc. When roots take up more water than is given off by leaves, the pressure built up may cause enlarged mesophyll cells to push outward through the epidermis. This condition is rare outdoors but is found in greenhouses and sometimes on house plants where they have been overwatered. Copper sprays sometimes produce similar intumescences. Camellias frequently have corky swellings on bottom surface of leaves, often due to water relations, sometimes to a spot anthracnose fungus.

Oxygen Deficiency, Asphyxiation

Overwatered house plants and crops in poorly drained low situations often show the same symptoms as those caused by lack of water, for the roots cannot respire properly and cannot take up enough water. Improve drainage; lighten soil with compost and sand; avoid too much artificial watering.

Phosphorus Deficiency

Young leaves are dark green; mature leaves are bronzed; old leaves are mottled light and dark green. In some plants there is yellowing around leaf margins. Stems and leafstalks develop reddish or purplish pigments; plants are stunted, with short internodes; growth is slow, with delayed maturity. Most complete commercial fertilizers have adequate phosphorus, but it can be added separately in the form of superphosphate. In preparing rose beds apply a liberal amount at the second spade depth as well as in the upper soil.

Potassium Deficiency

Marginal browning, bronzing, or scorching appears first on lower leaves and advances up the plant, which is stunted. Leaves are often crinkled, curl inward, develop necrotic areas; the whole plant may look rusty. The lack of potassium can be made up with a complete fertilizer containing 5 to 10% potash. Wood ashes also help to supply potassium.

Ring Spot

Yellow rings on African-violet foliage come from breaking down of the chloroplasts when the leaf temperature is suddenly lowered, as in watering with water considerably colder than room temperature.

Rosette

Zinc deficiency in pecan and walnut, boron deficiency in apple.

"Rust"

This term is used by amateur gardeners for any rust discolorations – for a leaf blight of phlox of unknown origin (probably a water relation), a spot necrosis of gladiolus, red-spider injury, and many other troubles that have nothing to do with true fungus rusts.

Salt Injury

Trees and shrubs along the seacoast are injured by ocean spray, and after hurricanes and high winds traces of injury can be found 35 to 40 miles inland. Conifers are usually affected most; they appear damaged by fire, with needles bright yellow, or orange-red. Eastern white pine is very susceptible; Austrian and Japanese black pines, blue spruce, and live oak are highly resistant. Roses have often survived submersion in salt water during hurricanes. Roadside trees, and e specially maples, may be injured by salt used on highways during the winter. Either sodium chloride or calcium chloride may be harmful.

Scald

Scald, of apple. Asphyxiation injury to fruit in storage from accumulation of harmful gases; most important when immature fruit is stored without adequate ventilation at too high temperature and humidity. Wrapping fruit in oiled paper or packing with shredded oiled paper, and storage near 32°F, with a high concentration of carbon dioxide at the start, control scald.

Scorch

► Leaf Scorch.

Shot Berry

Shot Berry, of grape. Defective pollination.

Smog Injury

Unsaturated hydrocarbons and ozone in the atmosphere are the cause, with many kinds of plants injured in the Los Angeles area. Tan lesions appear on fern leaves in 24 hours with necrosis in 24 more (Fig. 3.38). Many ornamentals and vegetables are injured, with annual loss $3 million. Spraying carnations in greenhouses with Vitamin C prevents sleepiness from smog. Some greenhouses have installed activated-carbon filters for polluted air.

Figure 3.38 Ozone Injury on Tobacco

Smoke Injury

The most important agent in smoke injury is sulfur dioxide, a colorless gas with a suffocating odor released from smelters and many industrial processes. Acute smoke injury shows in rapid discoloration of foliage, defoliation, sometimes death. Conifer needles turn wine red, in whole or part, then brown. Leaves of deciduous trees have yellow to dark brown dead areas between veins, with tissue next to larger veins remaining green. Chronic injury results in unhealthy, stunted trees, but less apparent discoloration and defoliation. Roses, grapes, and legumes are seriously injured. Gladiolus leaves appear burned from the tips down.

Control of injurious smoke must be at the source – by filters, tall smokestacks, neutralizing the acid gases, or using them in the manufacture of sulfur and sulfuric acid.

Soot Injury

City trees and shrubs acquire an accumulation of soot, the solid residue of smoke, which screens out the sunlight. Evergreens can be sprayed with a soapy solution of Calgon (sodium hexametaphosphate), followed by syringing with clear water.

Stigmonose

Dimpling of fruit by insect punctures.

Sulfur Injury

Sulfur sprays and dusts are likely to burn foliage in hot weather, when temperature is much over 85°F. There is often a browning of tip or margin of leaves. Lime sulfur is injurious to some plants in any weather, russeting peach foliage, causing apple drop, etc. When roses or other plants are continuously dusted with sulfur over a period of years, the soil may become too acid and require lime as a corrective.

Sunscald

Trees with smooth bark are subject to sunscald when trunks or branches are suddenly exposed to the sun, as when the next tree is removed. Young trees are subject to sunscald the first year or two after planting and should have trunks wrapped in burlap or sprayed with a protective wax to prevent the cambium under the thin bark from drying out.

Boxwood foliage is subject to sunscald in spring after winter covering is removed, particularly if this is done on a sunny day with drying winds.

Sunscald is common on green tomatoes when fruits are exposed to sun in hot dry weather (Fig. 3.39). This happens when foliage is lost through disease or excessive irrigation, or when too much is removed in training tomatoes to a single stem. A yellow or white patch appears on the side of the tomato nearest the sun, often developing into a blister, then into a large, flattened spot with a papery white surface darkened by the growth of secondary fungi and internal decay.

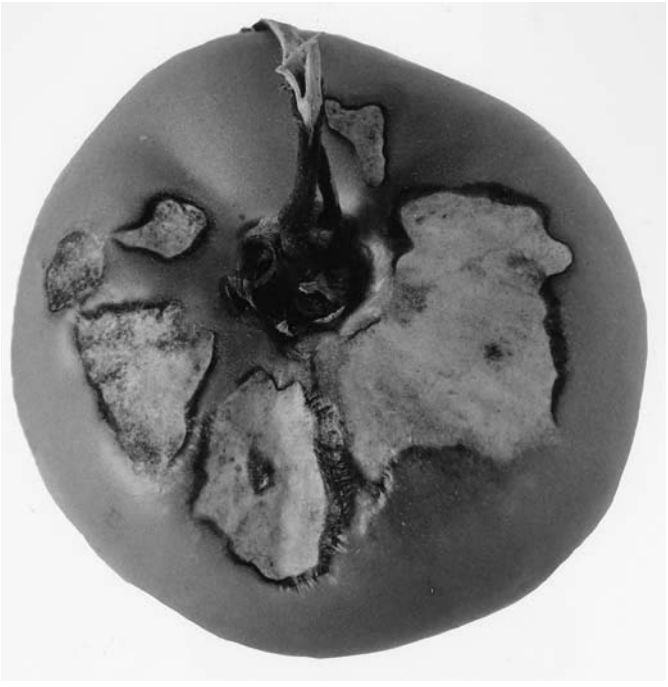

Figure 3.39 Tomato Sunscald

Sunstroke

Outright killing in excessive heat.

Tipburn

Potassium deficiency may produce a tipburn, but more often this is a reaction to heat, common in potatoes and particularly in lettuce, which shows marginal browning of leaves and small brown or black spots in tissues near larger veins. A regular supply of moisture and avoidance of excessive fertilization in warm weather reduce tipburn, but more reliance should be placed on growing varieties resistant to summer heat.

Topple

Topple, of gladiolus. Toppling over is apparently due to calcium deficiency; reduced by a spray of 2% calcium nitrate.

Variegation

Chlorophyll deficiency, genetic factors, and virus diseases can produce variegated plants.

Water Deficiency

Practically all of the injury laid to excessive heat or cold is basically due to lack of water. Winter winds and summer sun evaporate it from cells faster than it can be replaced from roots, so that the cells collapse and die.

Weed-Killer Injury

There has always been some unintentional injury to neighboring plants in the use of weed killers of the kill-all variety on driveways; but since we have had 2,4-D as a selective weed killer for lawns, the damage to innocent bystanders has been enormous, not only from spray drift and volatile material in the atmosphere but from using for other spraying purposes equipment that

Figure 3.40 Weed-Killer Injury; Tomato and Oak

has applied 2,4–D. It is impossible adequately to clean out such a sprayer; mark it with red paint and keep it for weeds only. Symptoms of injury are curling, twisting, and other distortions; there is often a fern-leaf effect instead of normal-size foliage (Fig. 3.40). I have seen roses seriously malformed when a factory several hundred feet away mixed up some 2,4-D. I have seen tall oaks with all leaves unrecognizable after powdered 2,4-D was applied

to the lawn. I have seen chrysanthemum in a greenhouse utterly deformed when 2,4-D was used on a lawn outside. Fortunately, unless the dose is too heavy, the plants gradually grow back to normal.

Winter Injury

Most winter browning of evergreens is due to rapid evaporation of water in sudden warm or windy spells. Copious watering late in the fall, a mulch, and windbreaks are helpful for broad leaf evergreens, as is spraying them with a waxy material, Wilt-Pruf, which prevents evaporation.
Sudden icestorms cause obvious breaking in trees; in boxwood and similar shrubs they result in bark sloughing off and gradual dieback for months, even years afterwards. I have seen symptoms on azaleas long after the ice was forgotten.

Yellows

This term is used for some deficiency disease but also for various virus diseases and Fusarium wilts.

Zinc Deficiency

Little Leaf of almond, apricot, apples, grape, peach, plum. Foliage is small, narrow, more or less crinkled, chlorotic at tips of new growth, with short internodes producing rosettes of leaves. Defoliation progresses from base to top of twigs. The method of supplying zinc depends somewhat on the fruit. Spray apples, peaches, plums, pears during dormant period with zinc sulfate. Swab grape vines immediately after winter pruning.
Mottle Leaf of citrus. Leaves are small, pointed, with a sharply contrasting pattern of green along midrib and main laterals and light green or yellow between veins.
Rosette of pecans and walnuts. Narrow, crinkled leaflets with dead or perforated areas have a rosette appearance; trees often bear no nuts. Pecan growers in southeastern states broadcast zinc sulfate on soil under each tree in winter. Variety Money-maker is resistant to zinc deficiency.
Vegetable crops – corn, beans, tomato, soybean – have been protected by amending the soil with 23 pounds zinc sulfate per acre.

POWDERY MILDEWS

Mildew is a disease in which the pathogen is seen as a growth on the surface of plants. The same word is used for the fungus causing the disease. Mildews are Ascomycetes. Black mildews are parasites in the order Meliolales with a dark mycelium to give a sooty effect. They are common in the South or on tropical plants in greenhouses (▶ Black Mildew). Powdery mildews are plant parasites in the order Erysiphales. They have white mycelium, in a delicate weft or thick felt, made up of a criss-cross tangle of hyphae. Colorless spores borne in chains on upright conidophores give the white powdery effect (see Fig. 3.41). False or downy mildews are oomycetes, and the conspicuous growth is not vegetative mycelium but fruiting structures and conidia protruding through stomata or epidermis to give a white frosty appearance in moist weather (▶ Downy Mildews).

True powdery mildews – and in speaking of them we usually eliminate the word "powdery" – are widely distributed but sometimes more abundant in semiarid regions than in areas of high rainfall, where other diseases flourish. Unlike those of most other fungi, powdery mildew spores do not require free water for germination. Some species require high humidity, but it is usually provided at the leaf surface when cold nights change to warm days or when plants are grown in crowded, low, or shady locations without sufficient air circulation. Spores of other species can germinate with very low humidity.

When a mildew spore lands on a leaf and puts out its germ tube, it does not make its nearest way inside the leaf but produces a tangle of septate threads, hyphae, on the surface. Special sucking organs, haustoria, penetrate the epidermal cells, occasionally the subepidermal cells, in search of food. The penetrating tube is slender, but, once inside the cells, the haustorium becomes a round or pear-shaped enlargement or a branched affair, with greatly increased absorbing surface.

Condiophores, growing at right angles from the mycelium, produce one-celled conidia in rows or chains of somewhat barrel-shaped hyaline cells, which become oval as they are dislodged from the top of the chain and dis-

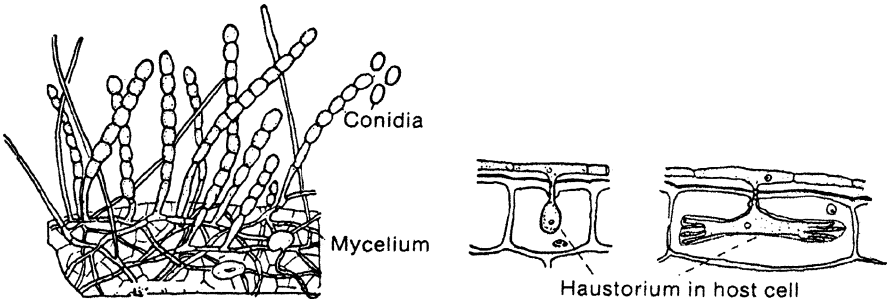

Figure 3.41 Powdery Mildew: mycelium and conidia formed on surface of a leaf and two types of the haustoria in host cells

seminated by wind. Mildews known only in this anamorph state are called by the form genus name *Oidium*. It requires the sexual fruiting bodies, perithecia, to place mildews in their proper genera.

Perithecia are round with a dark membranous wall, technically cleistothecia because they have no beak or ostiole, and rupture irregularly to free the asci. They are held in place in the mycelium by appendages. The form of these appendages and the number of asci in the perithecium are the chief characters differentiating the six genera important in this country (see Fig. 3.42). *Sphaerotheca* and *Erysiphe* both have simple appendages; but the former has only one ascus, the latter several. *Podosphaera* has appendage tips dichotomously branched and one ascus; *Microsphaera* has the same type of appendage but several asci. *Phyllactinia* has lancelike appendages swollen at the base; those of *Uncinula* are coiled at the tip. Both have more than one ascus.

Powdery mildews are obligate parasites, having no saprophytic growth periods in dead plant parts, although the perithecia carry the fungus through the winter on either living or dead tissue. Mycelium sometimes winters in buds. Symptoms of mildew are dwarfing and stunting, often with a slight reddening and curling of leaves before the white mycelium is noticeable. There may be deformation of flower buds. Such symptoms are due to the withdrawal of plant foods by the fungus and to excessive respiration.

Sulfur dust and lime sulfur sprays have long been considered specific remedies for powdery mildews; some copper sprays are effective. Many of the newer organics are ineffective. However, inorganics, in a formulated form, i. e. potassium biocarboante are very effective and safe.

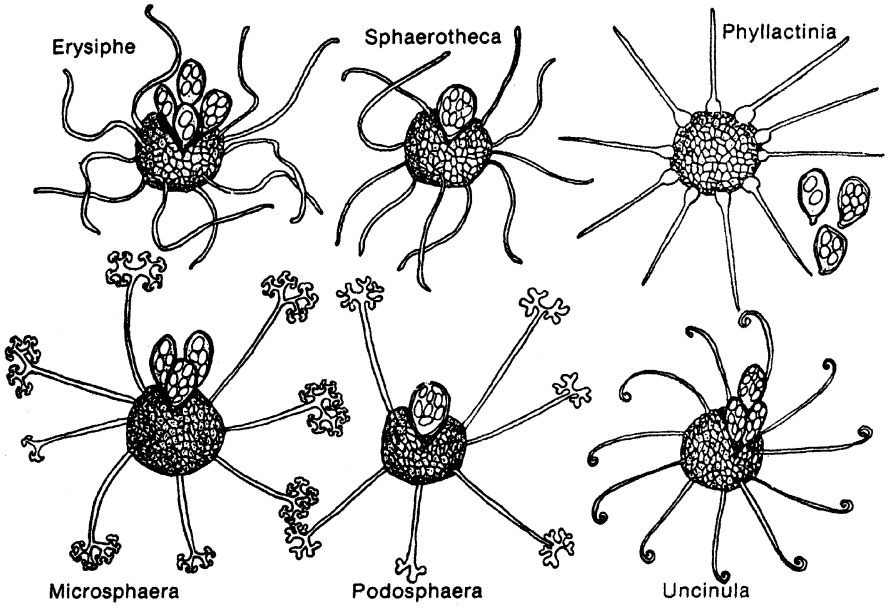

Figure 3.42 Powdery Mildews. Perithecia (cleistothecia) of the six genera: *Erysiphe*, simple appendages and several asci; *Sphaerotheca*, same with one ascus; *Mycrosphaera*, dichotomously branched appendages and several asci; *Podosphaera*, same with one ascus; *Phyllactinia*, appendages bulbous at base; *Uncinula*, appendages coiled at tip

Erysiphe

Cleistothecia globose, or globose-depressed, sometimes concave; asci several, two- to eight-spored; appendages floccose (cottony), simple or irregularly branched; sometimes obsolete, usually similar to mycelium and interwoven with it; mycelium brown in rare cases.

Blumeria graminis (see *Erysiphe graminis*). **Powdery Mildew** of cereals and grasses, economically important on bromegrass, wheat, oats, barley, and rye; aesthetically important on lawn grasses, wheatgrass, fescue, and bluegrass.

Brasiliomyces trina (formerly *Erysiphe trina*). **Oak Powdery Mildew**, on tanbark oak and coast live oak, in California, causing witches' brooms (but ►*Sphaerotheca lanestris* for the common live-oak mildew). Perithecia are small, yellow-brown, with appendages lacking or rudimentary; asci have two, rarely three, spores.

Erysiphe aggregata. **Alder Powdery Mildew**. Perithecia large, asci with eight spores, rarely six or seven.

Golovinomyces cichoracearum (formerly *Erysiphe cichoracearum*). **Powdery Mildew** of cucurbits and many ornamentals, mostly composites, perhaps best known to gardeners as the **Phlox Mildew**. Asci are two-spored, perithecia rather small, haustoria not lobed. There are nearly 300 hosts including: cucumber, squash, pumpkin, gourds, cantaloupe, watermelon, lettuce, endive, Jerusalem artichoke, pepper, potato, salsify, Echinacea, Eucalyptus, *Achillea, Anchusa, Artemisia*, aster, begonia, *Boltonia*, calendula, campanula, chrysanthemum, clematis, coreopsis, cosmos, dahlia delphinium *Eupatorium*, gaillardia golden-glow, goldenrod, *Helenium*, hollyhock, *Inula*, mallow *Mertensia* phlox, rudbeckia, *Salpiglossis*, salvia (sage), sunflower, stokesia and zinnia.

There are various strains of the fungus, the form on cucurbits not affecting ornamentals, the strain of phlox (see Fig. 3.43) is reportedly limited to that host, the strain on zinnia with a wide range of host plants. The lettuce strain, perhaps a mutation of the form on wild lettuce, was not reported on cultivated lettuce before 1951 and is important only in California and Arizona.

Powdery mildew was reported on cucurbits in North America in 1890, but did not gain much prominence until 1926, when it suddenly reduced the melon crop in the Imperial Valley of California by 5000 carloads. By 1939 mildew-resistant Cantaloupe 45 had been developed to meet the situation, but in another decade the fungus had produced a different strain to which Cantaloupe 45 was susceptible. Plant breeders can never rest on their laurels because fungi that are obligate parasites seldom stay long outwitted. Other varieties, Cantaloupes 5, 6, and 7, were bred resistant to both strains of the fungus.

Powdery mildew is the principal disease of cucumbers in greenhouse culture, with tiny white superficial spots on leaves and stems enlarging and becoming powdery. Young watermelon fruits in greenhouses have small pimples or warts under the area covered by mildew mycelium.

Phlox mildew is only too familiar to gardeners. The white coating often appears on variety Miss Lingard in June, but on other varieties (in New Jersey) more prominently in July and August. The mycelium is present on both leaf surfaces and forms a thick felt on stems. In late summer black perithecia are formed in great abundance. Powdery mildew on zinnias and chrysanthemums usually starts so late in the season that it is more conspicuous than harmful.

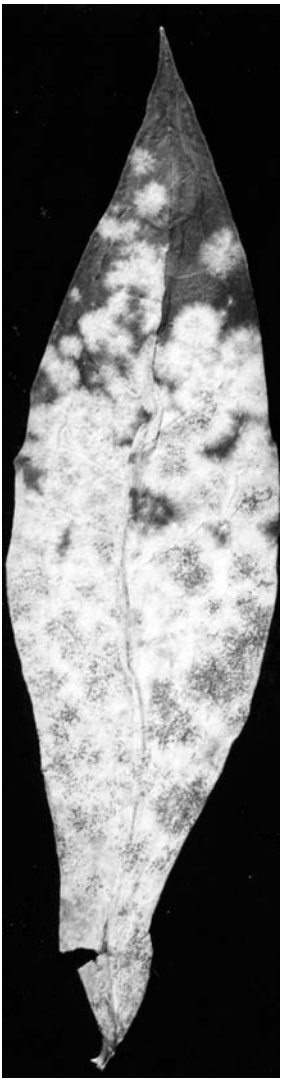

Figure 3.43 *Erysiphe cichoracearum* on Phlox

Control. Sulfur dust gives excellent control but is phytotoxic to some melons and other cucurbits. Sulfur-tolerant cantaloupes have been produced. The variety Homegarden is supposedly resistant to mildew and other pests. Keep phlox and other ornamentals well spaced, and dust with sulfur at the first sign of white growth. Because the perithecia winter on old stems and leaves, plants should be cut at ground level in autumn and burned.

Erysiphe cruciferarum. **Powdery Mildew** on cabbage and turnip.
Erysiphe graminis (syn. **Blumeria graminis**). **Powdery Mildew** of cereals and grasses, economically important on bromegrass, wheat, oats, barley, and rye; aesthetically important on lawn grasses, wheatgrass, fescue, and bluegrass. The foliage is yellow or chlorotic with a white weft or mealy coating on upperside of leaf, which later turns yellow and is often studded with tiny brown perithecia. Seed from infected plants is small and shriveled. Apply sulfur dust or wettable sulfur sprays.
Erysiphe heraclei. **Powdery Mildew** on carrot, parsley, chervil (culinary herb), and celery.
Erysiphe orontii. **Powdery Mildew** on mint.
Erysiphe panax. **Powdery Mildew** on ginseng.
Erysiphe polygoni. **Powdery Mildew** of legumes, and many other vegetables and ornamentals, about 200 species in 90 plant genera. Appendages are long or short, interwoven with the mycelium, but the perithecia are not immersed in it. Asci have three to six spores. Peas exhibit a white powdery coating over leaves and pods, with the latter often discolored. Leaves are sometimes yellowish and deformed. The disease may be severe on peas in arid sections of western states, particularly on late homegarden varieties.
On beans, the mildew is grayish. It is prevalent in California in cloudy weather or in autumn when humidity is increased, but it is more important in the Southeast. Other vegetables infected by this species include lima bean, soybean, cabbage, turnip, radish, horse-radish, and carrot. Spores germinate at quite low humidity.
The legume mildew is widespread on lupine, occasional on sweet pea. Other ornamental hosts include acacia, anemone, arrowleaf clover, candytuft, calendula, California poppy, iceland poppy, China aster, clematis, columbine, dahlia, delphinium, *Erigeron*, gardenia, geranium, hydrangea, honeysuckle, locust, matrimony-vine, peony, sugar beet, and tulip-tree. Teleomorph state found on sugar beet in CO, MT, NB, WA, and WY.
Control. Choose resistant vegetable varieties or dust with sulfur. Spray or dust ornamentals with Karathane or sulfur.
Erysiphe taurica (► *Leveillula taurica*). On leaves of mesquite.
Erysiphe trina (see *Brasiliomyces trina*). **Oak Powdery Mildew**, on tanbark oak and coast live oak, in California, causing witches' brooms (but ► *Sphaerotheca lanestris* for the common live-oak mildew).
Erysiphe sp. **Powdery Mildew** on tomato.

Leveillula

Cleistothecia globose, or globose-depressed, sometimes concave; asci two- to eight spored; appendages floccose (cottony), simple or irregularly branched; usually similar to mycelium and interwoven with it.

Leveillula taurica (formerly *Erysiphe taurica*). On leaves of mesquite. Commonly causes powdery mildew on tomatoes in Eastern Mediterranean region and reported on fresh market tomato in California and Utah; also on cucumber, hibiscus, onion, guar, wild tobacco, cotton and desert bird of paradise.

Microsphaera

Cleistothecia globose to globose-depressed; appendages branched dichotomously at apex, often ornate; asci several, with two to eight spores.

Microsphaera penicillata. Named for the alder (*Alnus*), on which it is widespread, but best known to gardeners as the **Lilac Mildew**. It also infects many other trees, shrubs, and vines, including azalea, beech, bittersweet, birch, catalpa, dogwood, elder, elm, euonymus, forestiera, hazelnut, magnolia, mountain-holly, plane, New Jersey tea, privet, trumpetvine, and viburnum. According to some taxonomists the proper name of this species is *Microsphaera penicillata*, but *M. alni* is more familiar and still widely used. Mildew is prevalent on lilac in late summer and fall, sometimes in dry seasons, almost completely covering foliage with a thick white coating; but, because it comes so late in the season, it is not very injurious. It is also common on deciduous azaleas in late summer, forming a very thin grayish white coating with numerous prominent dark perithecia. This species is more prevalent than the legume mildew on sweet peas, but it is chiefly a greenhouse problem in spring, when temperatures and humidity are less uniform. The foliage may be malformed, dropping prematurely or drying out and shriveling.

Among tree hosts oaks are probably most susceptible, but it would seldom pay to attempt control measures except in nursery rows. On pecans the white coating starts forming on leaves and nuts in July with occasional defoliation, shuck splitting, and shriveled kernels. Most commercial pecan varieties are mildew-resistant.

Blueberry Mildew is caused by a special strain of lilac mildew, reported as *Microsphaera vaccinii*, and *M. penicillata* var. *vaccinii*. Varieties Pioneer, Cabot, and Wareham are said to be particularly susceptible; Concord, Jersey, and Rubel are intermediate; and Stanley, Rancocas, Harding, and Katherine, highly resistant. On some blueberries the mycelium is conspicuous on upper leaf surfaces, on others barely visible on underside. Midsummer defoliation weakens the bushes. Cranberries, farkleberries, trailing arbutus and lyonia are possible hosts to this strain.

Control. Bordeaux mixture is recommended for pecans – two applications, June and July. Dust blueberries with sulfur. Use sulfur on lilacs and other ornamentals.

Microsphaera diffusa. General on snowberry, widespread on wolfberry, coralberry, occasional on black locust, lima bean, kidney bean and soybean. Appendages are two to four times the diameter of the perithecia, with ultimate branches long, forming a narrow fork.

Microsphaera euphorbiae. On lima bean, euphorbia, roselle.

Microsphaera grossulariae. **European Powdery Mildew**, occasional on currant, gooseberry. There is a light weft of mycelium mainly on upper surface of leaves. For the more important American mildew ▶ *Sphaerotheca mors-uvae*.

Microsphaera penicillata. **Powdery Mildew** on *Leucothoë axillaris*.

Microsphaera pulchra. **Powdery Mildew** on flowering dogwood.

Oidium

This term is used for mildews known solely from the conidial stage. In some cases the type of conidial fructitication may suggest correct genera, but until perithecia are found, *Oidium* is preferred.

Oidium araliacearum. **Powdery Mildew** on English Ivy.

Oidium begoniae. **Begonia Mildew**, especially important on tuberous begonias on the West Coast, though it may also occur on fibrous-rooted begonias.

Oidium dianthi. **Carnation Powdery Mildew**.

Oidium euonymus japonici. **Euonymus Mildew**, general throughout the South and on the Pacific Coast on *Euonymus japonicus*. The mycelium forms a thick felt on the leaf surface, causing some yellowing and defoliation (see Fig. 3.44). I have seen this disease rampant in foggy coast towns like Beau-

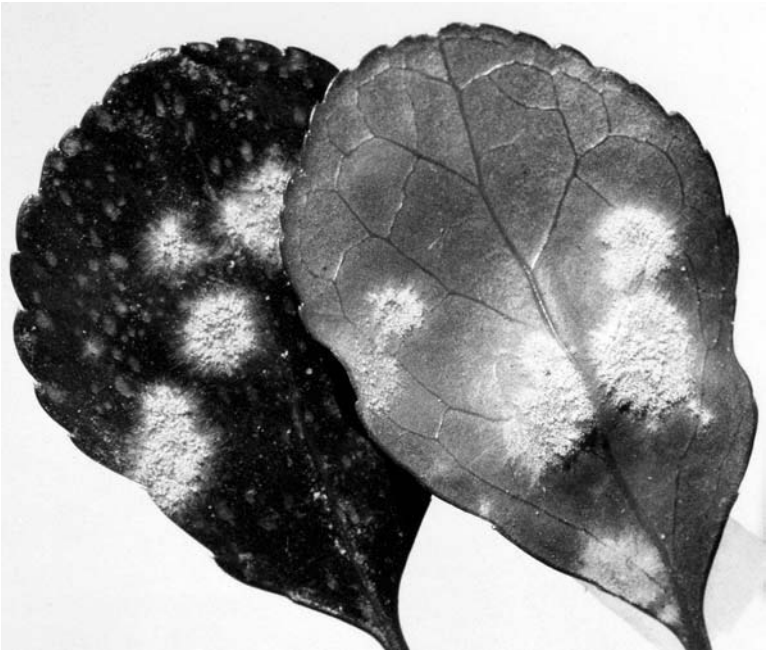

Figure 3.44 Powdery Mildew on Euonymus; prevalent in the South

fort, South Carolina, or Mobile, Alabama, and equally severe in semiarid El Paso, Texas. The washing effect of a water spray applied with pressure, either by adjusting the hose nozzle or putting the thumb over a portion of the orifice, is a deterrent to this mildew. Sulfur dust can be used, probably Karathane.

Oidium obductum. On oriental plane.

Oidium pyrinum. On crabapple.

Oidium tingitaninum. **Citrus Mildew**, common in Java, Ceylon, India, but in this country causing only limited injury to tangerine trees in California. White patches are formed on upper surface of leaves, the tissue underneath first a darker, watery green, then losing color, turning yellowish.

Oidium sp. On greenhouse snapdragons, a white powdery growth on both leaf surfaces, sometimes on young stems. Control with Karathane or sulfur.

Oidium sp. On avocado, occasionally in Florida, in nurseries or on young trees in shaded locations. Tips of shoots are killed back; dark green spots appear on upper leaf surfaces with white mycelium on the underside. The mildew can be controlled with lime sulfur. On alfalfa in Wisconsin.

Oidium sp. On shrub banana in LA.

Oidium sp. On black medic in CA.
Oidium sp. On *Melilotus alba* in FL.
Oidium sp. On poinsettia.
Oidium sp. On tomato.
Oidium sp. On Torena.

Phyllactinia

Perithecia are large; appendages are lancelike with a bulbous base. Mycelium does not send haustoria into epidermal cells of host but forms special branches that pass through stomata into intercellular spaces; each of these intercellular branches or hyphae sends a single haustorium into the adjacent cell.

Phyllactinia angulata. **Powdery Mildew** on elm.
Phyllactinia corylea (syn. *P angulata*). **Powdery Mildew** of trees, named for the hazelnut or filbert but prevalent on many other trees and shrubs, such as amelanchier, ash, barberry, beach, birch, boxwood, catalpa, chinaberry, crabapple, currant, blackberry, raspberry, gooseberry, crape-myrtle, dogwood, buttonbush, chestnut, elm, elder, fringe-tree, hawthorn, hickory, hornbeam, holly, linden, oak, plane trees, quince, rose, sassafras, tulip-tree, walnut and willow. Mildew is seldom serious enough on shade trees to warrant control measures, but in the nursery dusting with sulfur may be advisable. It is common on filberts in Oregon, but comes so late in the season it does not affect yield.

Podosphaera

Perithecia globose; one ascus, with eight spores; appendages dark brown or colorless, dichotomously branched at tip; rarely an extra set of basal appendages present.

Podosphaera leucotricha. **Powdery Mildew** of apple, also crabapple, pear, quince, photinia. First noted in Iowa on seedling apples in 1871, this mildew became more important in orchards when organic fungicides, ineffective for mildew, were substituted for sulfur and copper in the apple-scab schedule. Twigs, foliage, blossoms and fruits may be disfigured, stunted, deformed or killed. Gray to white felty patches are formed on leaves, usually on underside. Leaves are crinkled, curled, sometimes folded longitudinally and covered with masses of powdery spores. They soon turn brittle and

die, resulting in decreased yield. The same powdery growth starts on 1-year twigs, but in midsummer it is transformed into a brown, felty covering, in which minute, dark perithecia are embedded in dense aggregations. Infected twigs are stunted or killed. The fungus winters as dormant mycelium on twigs or in buds. Such buds produce shriveled blossoms and no fruit. Fruit produced on infected twigs is stunted or russeted. Jonathan variety is especially susceptible.

Podosphaera clandestina (*P. clandestina* var. *tridactyla*). **Powdery Mildew** of cherry, occasional on plum, peach, apricot, apple, pear, quince, hawthorn, serviceberry, spirea. Budded sour cherry is most severely attacked, but the disease is seldom serious except on nursery stock. Young leaves and twigs are covered with a white mycelium and powdery spores. Leaves are curled upward; terminal leaves are smaller; twig growth is stunted. Sulfur sprays or dusts will control.

Podosphaera pannosa (formerly *Sphaerotheca pannosa* var. *rosae*). **Rose Mildew**, general on rose; distinct from peach mildew but apparently not confined to rose, since apricots growing near roses have been infected. More than one strain may be involved. Rose mildew is found wherever roses grow. Always a problem with greenhouse roses, it was enhanced when aerosol treatments for red spiders and other pests were substituted for old-fashioned syringing. Mildew increased in garden roses when ferbam and other new organics replaced the old sulfur and copper in the blackspot sprays. Rose mildew is omnipresent along the Pacific Coast and is serious in the semi-arid Southwest. In the East, it appears on small-flowered ramblers such as Dorothy Perkins and Crimson Rambler in May, and may be quite serious on hybrid teas and some floribundas in late summer, with the advent of cool nights.

The first symptom may be a slight curling of leaves, with the mycelial growth such a light and evanescent weft as to be almost unnoticed. Later the white coating is conspicuous from the chains of conidia produced lavishly over the surface. The coating may cover buds, resulting in no bloom or distorted flowers. Leaves often have a reddish or purplish cast under the white mycelium and sometimes turn black. They may be slightly blistered. On canes, the growth is heavier and more felty, especially near thorns. Toward the end of the season perithecia may be found on canes, but they are not common, and I have not seen them on leaves except on a Rugosa rose at Ithaca, New York. Mildew is prevalent on soft succulent shoots, fostered by an excess of nitrogen.

Control. Sulfur dusts have been standard treatment for garden roses for many years; to be effective dusting must be started at the first sign of mildew, before the mycelium gets too thick. Sulfur may be injurious to roses in very hot weather. Choice of variety of rose is important. Shiny-leaved climbers like Dr. Van Fleet seldom have mildew, and the shrub polyantha, The Fairy, is very resistant. Many red roses, hybrid teas and fluoribundas, are especially susceptible, but the orange-red floribunda Spartan remains free from it (in my own experience). Garden planning avoids a lot of mildew trouble. Keep the plants well spaced, in beds away from buildings, and not surrounded by tall hedges or walls.

Podosphaera tridactyla. Recently reported on almond in California and the most common mildew on apricot, causing large nonnecrotic lesions on leaves.

Sphaerotheca

Appendages simple, flexuous, resembling hyphae; only 1 ascus in a perithecium.

Cystotheca lanestris (formerly *Sphaerotheca lanestris*). **Powdery Mildew** of coast live oak on *Quercus agrifolia* in California, reported also on white, southern red, bur and post oaks. The disease is most destructive in the narrow coastal plain. The most conspicuous symptom is a powdery white, stunted growth developing from certain terminal or lateral buds. The shoots are swollen, fleshy, with much shortened internodes. Foliage on such shoots is often reduced to pale yellow, bractlike leaves, which turn brown, dry, and shrivel; these shoots resembles witches' brooms. On leaves developing from normal buds and shoots, the fungus forms a dense layer on both surfaces, more abundant on the lower side. This species is sometimes called the brown mildew because the grayish-white mycelium changes to tan and then brown with age. Perithecia are formed in the brown felt, abundantly in some years, rarely in others. In southern California the fungus may winter in the conidial state, with widespread leaf and shoot infections coming from wind-borne spores.

Control is not easy. Spraying with lime sulfur in March and October is fairly effective but may be phytotoxic at high temperatures and low humidity. Wettable sulfur has not been consistently effective. Removal of witches' brooms by pruning back to normal lateral branches is effective only if the tree is slightly susceptible and conditions for reinfection are unfavorable. Heavy

pruning stimulates new growth and increases the amount of mildew. The Holm or holly oak is apparently resistant to mildew and well adapted to the coastal region.

Sphaerotheca castagnei (see *Sphaerotheca fuligena*). On buffaloberry, spirea.

Sphaerotheca fuliginea (formerly *Sphaerotheca castagnei*). On buffaloberry, spirea.

Sphaerotheca fuliginea. **Powdery Mildew** of summer squash and cucurbits.

Sphaerotheca fusca. Powdery mildew; on ground-cherry.

Sphaerotheca lanestris (see *Cystotheca lanestris*). **Powdery Mildew** of coast live oak on *Quercus agrifolia* in California, reported also on white, southern red, bur and post oaks.

Sphaerotheca macularis (*S. humuli*). **Hop Mildew**, also on fruits, blackberry, dewberry, gooseberry, raspberry, strawberry, rose (probably rarely in this country), and other ornamentals, including *Agastache*, betony, buffaloberry, delphinium, *Epilobium, Erigeron*, gaillardia, geranium, geum, gilia, hawksbeard, hawkweed, *Hydrophyllum*, kalanchoë, matricaria, meadowsweet, ninebark, *Polemonium*, phlox, sumac, spirea, tamarisk and *Vernonia*.

This mildew may be important on Latham variety of raspberry, appearing on new canes when they are 2 to 3 feet high. The tip leaves are dwarfed, mottled, and distorted, almost as if they had mosaic. The undersurface of leaves is water-soaked or has the familiar white coating. There is no specific control except to space plants for free air circulation.

The powdery mildew sometimes serious on strawberries in northeastern and Pacific Coast States is probably a special strain. The edges of affected leaves curl upward, exposing the lower surface, where the powdery frosty growth is evident. Fruit, stems, and berries may be affected, with fruit often failing to color. Resistant varieties include Sparkle, Puget Beauty, Siletz and India.

Sphaerotheca mors-uvae. **American Gooseberry Mildew**, also on currant; sometimes the limiting factor in gooseberry production. Fruits dry up with a brown, felty covering. Leaves and canes are stunted with the usual white coating. Perithecia are formed on canes, and ascospores are discharged in early May as fruit is set. Conidia for secondary infection are produced within 10 days. Spray with lime sulfur immediately after bloom.

Sphaerotheca pannosa var. **persicae**. **Peach Mildew**, general on peach, also on almond, apricot, nectarine, matrimony-vine, and *Photinia*. The

mycelium is pannose (ragged) or in dense patches, persistent, usually satiny, shining white, or sometimes grayish or brown. Immature fruits are highly susceptible. They have brown blotches and are scabby and malformed. The fungus winters in shoots. Nonglandular varieties Peak and Paloro are more affected than glandular Walton, Johnson, Halford, and Stuart, at least in California. Sulfur in the spray schedule for brown rot should control mildew without additional treatments. Karathane is effective but very slightly phytotoxic. Lime sulfur is recommended.

Sphaerotheca pannosa var. **rosae** (▶ *Podosphaera pannosa*). **Rose Mildew**, general on rose; distinct from peach mildew but apparently not confined to rose, since apricots growing near roses have been infected.

Sphaerotheca phytoptophila. Associated with gall mites causing witches' brooms on hackberry. The mycelium is evanescent; perithecia are formed inside loose scales of enlarged buds.

Sphaerotheca sp. On *Tolmiea*, pick-a-back plant, in greenhouse.

Uncinula

Perithecia globose; appendages uncinate, slightly coiled at tips; several asci, with two to eight spores.

Pleochaeta prosopidis (formerly *Uncinula prosopidis*).

Uncinula circinata. On maples, Virginia creeper, western soapberry.

Uncinula clintonii. General on American linden.

Uncinula flexuosa (see *Uncinuliella flexuosa*). **Horse-Chestnut Powdery Mildew**, on *Aesculus* spp., including red, yellow and Ohio buckeye, widespread in central and eastern states.

Uncinula macrospora. General on American and winged elms.

Uncinula necator. **Grape Powdery Mildew**, general on grapes, also on *Ampelopsis*; common in late summer on eastern grapes but not serious; a major problem in California. Leaves, canes and young fruits are covered with white patches; growth is often distorted. Late in the season the white mycelium disappears and the spots appear brown or black; berries are russeted or scurfy, failing to mature.

Control. Keep California grapes covered with a light coating of sulfur dust. Apply when new shoots are 6 to 8 inches long; when they are 12 to 16 inches, 14 days later; when shoots are 2 to 3 feet; when fruit is half.grown; when

fruit begins to ripen. If some of the applications are omitted, and mildew gets a head start, wettable sulfur is used as an eradicant spray. Karathane is also effective. Copper sprays are often used in the East, if any are necessary. Bicarbonate sprays are excellent as protectant and eradicant.

Uncinula parvula; **U. polychaeta**. Widespread on hackberry and southern hackberry.

Uncinula prosopidis (see *Pleochaeta prosopidis*). On mesquite.

Uncinula salicis (see *Uncinula adunca*). **Willow Powdery Mildew**, also on pussy willow and poplar, sometimes causing defoliation but not often serious.

Uncinuliella australiana. (not *Erysiphe lagerstroemiae* as reported earlier in U.S.). **Crape-Myrtle Powdery Mildew** on crape-myrtle only, from Maryland to Florida and Texas, the most serious disease of this shrub. The perithecia have been found only in Florida, but presumably it is the same species throughout the host range. The disease appears on young shoots in early spring, later infecting leaves and different parts of the influorescence. Affected parts are covered heavily with a white mealy to dusty growth; young leaves are stunted, often less than one-third normal size but abnormally thickened. Internodes are short, flower stems stunted; buds often fail to develop flowers. Infected portions often have a reddish discoloration under the white coating. Diseased leaves and buds drop in a week or two, but stems may sprout again and sometimes produce normal growth in hot weather.

The fungus winters as mycelium in dormant buds and in spring covers such buds with a dense white coating of conidia, the source of primary infection, which starts as small, circular white patches on young leaves. Spores produced in abundance on these patches account for rapid spread of the disease until midsummer heat.

Control. Spray with lime sulfur when buds burst in spring and repeat 2 weeks later. If the initial infection is not checked, spray wettable sulfur or dust with sulfur.

Uncinuliella flexuosa (formerly *Uncinula flexuosa*). **Horse-Chestnut Powdery Mildew**, on *Aesculus* spp., including red, yellow and Ohio buckeye, widespread in central and eastern states. This mildew gives a very thin coating on the leaf surface, supposedly mostly on the underside although I have seen it on the upper. Perithecia are numerous, small, barely discernible with the naked eye. Control is usually unnecessary except in nurseries. A copper spray used for blotch will also control mildew.

Uncinula adunca (formerly *Uncinula salicis*). **Willow Powdery Mildew**, also on pussy willow and poplar, sometimes causing defoliation but not often serious. The growth is in diffused or circumscribed patches on both leaf surfaces.

ROTS

A rot is a decay, a decomposition or disintegration of plant tissue. It may be a hard dry decay or a soft and squashy one. It may affect root or rhizome, stem, tree trunk, blossom or fruit. Some rots also affect leaves, but diseases that are primarily of foliage are more often designated leaf spots or blights. Rots caused by bacteria are discussed under Bacterial Diseases.

There are a great many wood rots of trees, recognized by the sporophores or conks of the various species of *Fomes, Polyporus*, and other shelving or bracket fungi. By the time these signs appear, it is usually too late to do anything about the disease. The tree-rot fungi enter through unprotected wounds – either pruning cuts or breaks due to wind and icestorms. For proper pruning methods and treatment of wounds, see U.S. Department of Agriculture Farmers' Bulletin 1896, *Care of Damaged Shade Trees, Tree Maintenance* by P. P. Pirone or *Tree Experts Manual* by Richard R. Fenska. The fact that tree wound dressings are now available in convenient aerosol bombs should make it easier for home gardeners to protect pruning cuts from wood-rotting fungi.

Physalospora (Acanthorhynchus)

Ascomycetes, Amphisphaeriales

Perithecia separate, innate, beaked; spores one-celled, dark.

Acanthorhynchus vaccinii (see *Physalospora vaccini*). **Cranberry Blotch Rot**, a common fruit rot thriving in warmer sections, more important in New Jersey than in Massachusetts.

Physalospora vaccini (formerly *Acanthorhynchus vaccinii*). **Cranberry Blotch Rot**, a common fruit rot thriving in warmer sections, more important in New Jersey than in Massachusetts. The rot starts as a small, light-colored spot on the berry, spreading to destroy the whole fruit, with dark blotches on the skin. The fungus may invade leaves, but it seldom fruits on them

until they have fallen. Cranberry bogs in New Jersey may need three or four sprays of Bordeaux mixtures starting at midbloom, but in Massachusetts two are sufficient.

Acremonium

Acremonium sp. **Root Rot** on melon and watermelon.

Alternaria

► Blights.

Alternaria alternata. **Fruit Rot** on tomato and black pit disease on potato tubers (stored).

Alternaria citri. **Alternaria Rot** of citrus fruits, navel-end rot, black rot, widespread, prevalent in warm dry sections, but not too serious. In oranges the rot is most common in the Washington Navel variety – a firm, dry, black rot at the navel end, often in only one segment, with fruit coloring prematurely, appearing sound on the outside. In lemons the disease is a soft, dark internal rot of old or weak fruit in storage. Firm dark brown spots are formed on the rind. Grapefruit sometimes has a dark internal storage rot, not readily discernible externally.

Control. Chemical treatment after picking is not very satisfactory. Produce sound fruit in the orchard; avoid holding too long on the tree; avoid holding weak or old fruit too long in storage; store at low temperatures.

Alternaria mali. **Fruit Rot**, widespread storage rot of apple, sometimes quince. Also a weak parasite enlarging injured spots on foliage. Try captan at 6- to 14-day intervals.

Alternaria radicina (Syn. *Stemphylium radicinum*). **Black Rot** of carrots, a soft storage rot of roots held over winter. Rot may start at the crown or from some wound on the side of the root. Initial infection may be in field or in storage house; a black mycelial weft with large, brown muriform spores develops over the rotted tissue. There is no control except to choose firm, healthy roots for storage and to store at low temperatures.

Alternaria solani. **Collar Rot** of tomato, also fruit rot and early blight, general on tomato with the collar rot stage most frequent in the South. ► Blights.

Alternaria zinniae. **Stem Rot** on *Ageratum*.

Alternaria sp. **Flower Rot** of Vanda orchids, causing infection in transit along with *Botrytis*.
Alternaria sp. On Schefflera in Florida.
Alternaria sp. **Calyx-End Rot** on apple.

Amphobotrys

►Cankers and Dieback.

Amphobotrys ricini. **Stem Rot** and **Wilt** of poinsettia.

Aphanomyces

Phycomycetes, Saprolegniales.

Thallus composed of cylindricaI branching hyphae without definite constrictions; sporangium cylindrical, threadlike, swarm spores arranged in a single row and encysting at the mouth; saprophytic or parasitic, living in the soil and causing root rots or damping-off.

Aphanomyces cladogamus. Causing rootlet necrosis of tomato, pepper, spinach, and a severe root rot of pansy.
Aphaomyces cochlioides. A seedling disease of sugar and table beets, part of the complex called black root; causing tip rot, a wilting of tops. Crop rotation and proper fertilization are helpful.
Aphanomyces euteiches. **Pea Root Rot**, also on bean, sweet pea and perennial pea. The fungus is also a weak parasite in roots of many non-legumes. First described in 1925, the fungus probably existed earlier in various root disease complexes and was responsible for giving up land formerly devoted to canning peas. Considered the most important of the pea root rots, found in every district, it is particularly destructive in eastern and central states.
The fungus is parasitic on subterranean parts, causing root and stem rot in peas of all ages, symptoms and crop yield varying with the time of infection. If the root system is invaded when only three or four nodes are formed, the plant may wilt and die suddenly; later invasion results in dwarfing and drying out of foliage from the ground upward. When seedlings are pulled out of the ground, the roots do not break off but come out as a fibrous string or vascular cylinder freed from cortex. The fungus invades only the cortex or roots and

base of stem, causing softening and rapid decay of tissue. Large numbers of thick-walled oospores are formed in the cortex; these may remain viable in the soil more than one season.
It is a novel root pathogen on alfalfa in Canada.
Control. A well-drained soil with low moisture content decreases rot. When soil moisture is at 45% of saturation, there is no disease; at 75% there may be more than 70% infection. Nitrogenous fertilizers are helpful.
Aphanomyces raphani. **Radish Black Root** and **Damping-Off**, widespread; more important on long-rooted icicle varieties. Also on Abyssinian mustard, cabbage, Chinese cabbage, Chinese kale, honesty, mustard green, rape, rocuet salad, sea-kale, Spanish mustard, wild radish and *Brassica robertiana*. Small, steel-gray to black areas appear around point of emergence of secondary roots. Enlarging roots are constricted and turn black. Rotation is essential for control. Choose globe rather than long varieties.

Armillaria

Basidiomycetes, Agaricales.

One of the mushrooms, cap-shaped on a stalk with an annulus or ring but no volva (cup) at the base; gills attached to the stem; spores white (see Fig. 3.45).

Armillaria mellea. **Mushroom Root Rot** of trees and shrubs, also known as Armillaria root rot or toadstool disease, first described in America in 1887, known in Europe a hundred years earlier. The fungus is called honey mushroom, honey agaric, oak fungus and shoestring fungus. Although the honey-colored toadstools are often seen in the East around rotting tree stumps and may occasionally cause death to weak ornamental trees, the chief damage is west of the Rocky Mountains, especially in California, where most fruit and nut crops and ornamental trees and shrubs are menaced.
The decay is of the roots and root crown. Sheets of tough, fan-shaped mycelium are found between bark and wood, the latter changing to light tan, becoming soft and watery in texture. Clumps of toadstools are often found at the base of dead or dying trees, especially in autumn, but do not always appear in dry seasons. They are honey-colored or light tan, with a stalk 4 to 6 inches or more high and a cap 2 to 4 inches across, often dotted with brown scales. Basidiospores formed along the gills are wind-borne. They can establish themselves in old stumps and dead trees but cannot infect healthy trees. The latter are infected in the ground by means of black or brown cordlike

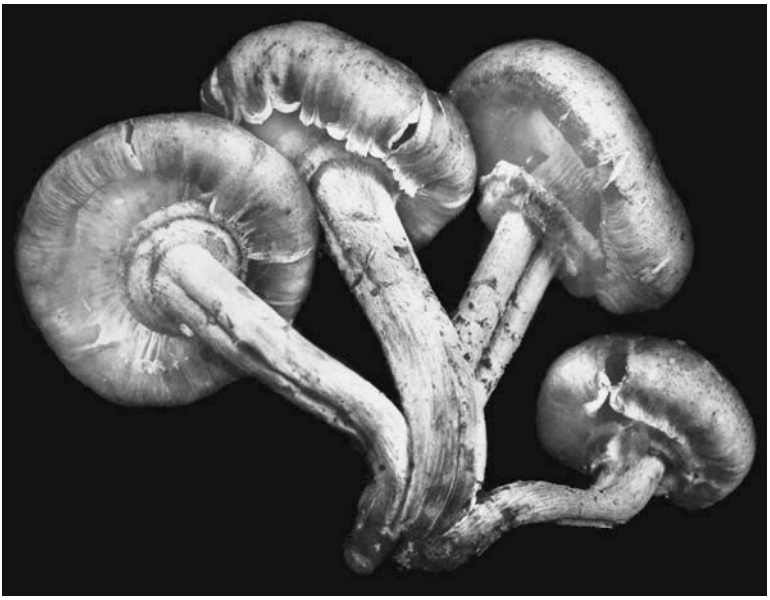

Figure 3.45 Mushroom Root-Rot Fungus, *Armillaria mellea*

rhizomorphs, the "shoestrings," which grow out from infected roots a short distance through the soil. On meeting and penetrating a healthy root, the fungus progresses along the cambium layer, working up to and girdling the root crown. Leaves are dwarfed, turn yellow or fall prematurely; on small trees all foliage may die simultaneously. On conifers, particularly pines, there is an abnormal flow of resin from the root collar.

Trees subnormal in vigor and suffering from drought are most injured. Orchards of citrus and other fruits on lands recently cleared of oaks are liable to enormous damage unless resistant rootstocks are used. The rot is found less often on dry hillsides than in valleys near streambeds, where flood waters deposit soil and infected debris around root crowns, or in places kept too wet by artificial watering. Ornamental trees and shrubs are often injured when extra soil is added in grading and terracing, and are then kept too wet by watering the lawn frequently.

The list of susceptible plants is far too long to be given in entirety. A representative selection includes almond, apple, apricot, avocado, cherry, citrus, currant, grape, incense cedar, peach, pear, plum and raspberry, hickory, filbert and walnut, California pepper-tree; oaks, pines, spruce and sycamore;

azalea, rhododendron, boxwood and rose; (root, crown, and stem rot on) African daisy and (stem rot on) sunflower;and sometimes other herbaceous plants such as begonia, carnation, dahlia, narcissus, peony, rhubarb, and strawberry.

Control. Use resistant plants where possible. Of fruits, only French pear, Northern California black walnut, fig and persimmon are sufficiently resistant to grow safely on infested soil. Some plants can be grafted onto resistant rootstock such as Myrobalan 29. The University of California has prepared a list of resistant or moderately resistant ornamental shrubs. Some on the list are *Acacia decurrens* var. *mollis, A. verticillata, Buxus semipervirens, Ilex aquifolium, Lonicera nitida, Prunus ilicifolia* (hollyleaf cherry), *P. lyoni* (Catalina cherry), *Pyracantha coccinea* and var. *lalandii* but not *P. angustifolia*, which is susceptible.

Moderately resistant shrubs include *Abelia grandiflora*, Darwin, Japanese, and Mrs. Wilson barberry, Mexican orange (*Choisya*), *Elaeagnus argentea, Euonymus japonica*, Japanese privet, *Myrtus communis, Pittosporum tobira* and *Spiraea prunifolia*.

Mechanical measures are often helpful. Excavate and expose the root crown; remove diseased portions of bark and affected small roots. Paint wounds with a pruning wound compound. Leave the treated roots exposed until cool weather in autumn. Trenching or digging a ditch around a plot will restrict the disease temporarily, but roots will grow through the ditch in time.

Carbon disulfide is still recommended as a soil disinfectant, applied in staggered rows, in holes 18 inches apart each way, which should be immediately closed by tamping. Hand applicators are available for injecting the disulfide 6 to 7 inches deep. This treatment is for land where valuable trees have been removed; one cannot go closer to a healthy tree than the edge of the branch spread. After treatment, the land should remain fallow for at least 60 days, and then be ploughed before planting.

Ascochyta

► Blights.

Ascochyta pinodes. **Foot Rot** of peas. Of the three species that make up the Ascochyta blight complex, this one produces most definitely a foot rot, with infection at the root crown or base of stem.

Aspergillus

Deuteromycetes, Coelomycetes

Conidiophores have a round head at the top, with radially arranged bottle-shaped sterigmata that bear conidia in chains; spores are one-celled, globose to ellipsoid, hyaline. Bread molds are in this genus. When, rarely, a sexual fruiting body (cleistothecium) is formed, the species is placed in the order Eurotiales.

Aspergillus alliaceus. **Cladode Rot**, **Stem and Branch Rot** on *Cereus* and *Opuntia* cacti. This is a high temperature species. Spores are yellow in mass.
Aspergillus fumigatus. **Wound Rot** (storage) on beet.
Aspergillus niger. **Calyx-End Rot** of dates, **Fig Smut**, **Bunch Mold** of grapes, **Pomegranate Rot**, **Black Mold** of peach. **Crown Rot** of peanut; also market and storage rot of shallot, onion, apple and potatoes. The fungus is a weakly parasitic black mold invading ripe tissue through wounds. In dates, the interior of the fruit is filled with a black dusty mass of spores, spread to a large extent by the dried-fruit beetle. Practice orchard sanitation; keep decaying fruits cleaned up so insects cannot carry spores.
Aspergillus niger var. **floridanus**. Wound parasite on *Dracaena*. Lower stem black, rotted, with dark brown spore masses.
Aspergillus spp. Green and yellow molds causing secondary rots of many fruits and some vegetables in storage.

Lasiodiplodia (Botryodiplodia)

► Blights.

Botryodiplodia theobormoae (see *Lasiodiplodia theobromae*). **Root Rot** on apple
Lasiodiplodia theobromae (formerly *Botryodiplodia theobormoae*). **Root Rot** on apple.

Botryosphaeria

► Blights.

Botryosphaeria dothidea. **Fruit Rot** of peach and grape.

Botryosphaeria obtusa. **Fruit Rot** of peach, **Black Root Rot** of apple.
Botryosphaeria rhodina. **Fruit Rot** of peach.
Botryosphaeria ribis (Anamorph, *Dothiorella gregaria*). **Dothiorella Rot** of avocado and citrus, **Black Fruit Rot** of apple and pear, **Nut Rot** of tung oil. On avocado this is a soft rapidly spreading surface rot, starting from small spots when fruit begins to soften. The fruit may be covered with decay spots by the time it is usable. The fungus winters in dead twigs, in tip-burned leaves, and enters the avocado while it is still on the tree. Two sprays, mid-September and early October, using bordeaux mixture, have given fairly good control. Remove dead wood from trees, to reduce source of inoculum, and pick fruit early.
On lemons and other citrus fruits the rot starts as a discoloration around the button, becoming a brown, leathery but pliable decay. When fruit is entirely involved it becomes olivaceous black. On tung, brown lesions appear on green fruit, which drops prematurely. See further under Cankers.

Botryotinia

► Blights.

Botryotinia convoluta. **Botrytis Crown Rot** of iris, **Gray Mold Rot** on rhizomatous iris, first recorded in Canada in 1928 and apothecia later produced in culture. The chief diagnostic character is the presence of many shining black sclerotia, much convoluted and agglomerated into large clusters on rotting rhizomes. These are often found in spring on plants that started into the winter apparently healthy, for the fungus is active in cool, wet weather. Conidiophores are brown, formed in fascicles, and bear dense clusters of light brown ovate or slightly pyriform conidia. They appear in spring growing from or near sclerotia. Affected plants do not start spring growth.

Botrytis

► Blights.

Botrytis aclada. **Gray Mold Neck Rot** of onion, also shallot and garlic; widespread. This is usually found on bulbs after harvest, infection taking place through neck tissue and scales appearing sunken and “cooked.” Scle-

rotia are first white, then dark, 2 to 4 mm across. Conidiophores and conidia forming the gray mold are produced directly from mycelium in tissue or from sclerotia. Artificially cure bulbs after harvest to cause rapid dessication of neck tissue; store at low temperature. Colored varieties keep better than white.

Botrytis byssoidea. **Mycelial Neck Rot** of Onion. The fungus is much like *B. aclada* but produces more mycelium and less profuse gray mold.

Botrytis cinerea. **Gray Mold Fruit Rot**, **Cosmopolitan** on peach, cherry, plum, pomegranate, quince, pear, grape, strawberry, pepper, tomato and eggplant. Also causing a leaf rot of hothouse rhubarb and a rot of carrot, lettuce, celery and onion. See further under Blights.

Botrytis gladiolorum. **Botrytis Neck Rot**, **Corm Rot**, **Blight** of gladiolus. ► Blights.

Botrytis porri. Seedborne causing natural infection.

Botrytis (Teleomorph, *Botryotinia*) **squamosa**. **Small Sclerotial Neck Rot** of onion. Elliptical leaf lesions with withering of tips.

Botrytis tulipae. **Bulb Rot** of Vidalia sweet onion.

Brachysporium

Deuteromycetes, Hyphomycetes

Conidiophores brown, erect, usually solitary, septate; conidia dark, unequally two- or more-septate; attached to apical cell of conidiophore by a short narrow cell; saprophytic.

Brachysporium tomato. **Fruit Rot** of tomato.

Calonectria

See *Cylindrocladium* under Blights.

Calonectria crotalariae. **Basal Stem Rot** of oleander.

Calonectria sp. (Anamorph, *Cylindrocladium*). **Crown and Collar Rot** on papaya.

Catenularia

Deuteromycetes, Hyphomycetes

Hyphae dark; conidophores simple or sparingly branched, with terminal chains of conidia; spores dark, one-celled.

Catenularia fuliginea. **Fruit Rot** of date.

Mycocentrospora

Deuteromycetes, Coelomycetes

Spores hyaline, filiform, with long, whiplike tapering beaks, several cross walls and a swordlike appendage from basal cell; mycelium dark.

Centrospora acerina (see *Mycocentrospora acerina*). **Black Crown Rot** of celery, **Storage Rot** of carrot.
Mycocentrospora acerina (formerly *Centrospora acerina*). **Black Crown Rot** of celery, **Storage Rot** of carrot (see Fig. 3.46). On celery the disease appears 7 or 8 weeks after stock has been placed in cold storage with pale, ochraceous lesions at the crown end, gradually turning black, sometimes reddish. The fungus lives in the soil; use infested fields for early celery to be marketed without storage. The same species also causes leaf spot of pansy.

Cephalosporium

► Leaf Spots.

Cephalosporium carpogenum. **Fruit Rot** on apple in storage, reported from Washington and Pennsylvania.
Cephalosporium gregatum (see *Phialophora gregata*). **Brown Stem Rot** of soybean.
Phialophora gregata (formerly *Cephalosporium gregatum*). **Brown Stem Rot** of soybean.
A vascular disease of major importance in the Midwest, also present in Florida, North Carolina and Virginia. It has been controlled with a long rotation – 5 years corn, 1 year soybeans.

Ceratocystis

► Cankers.

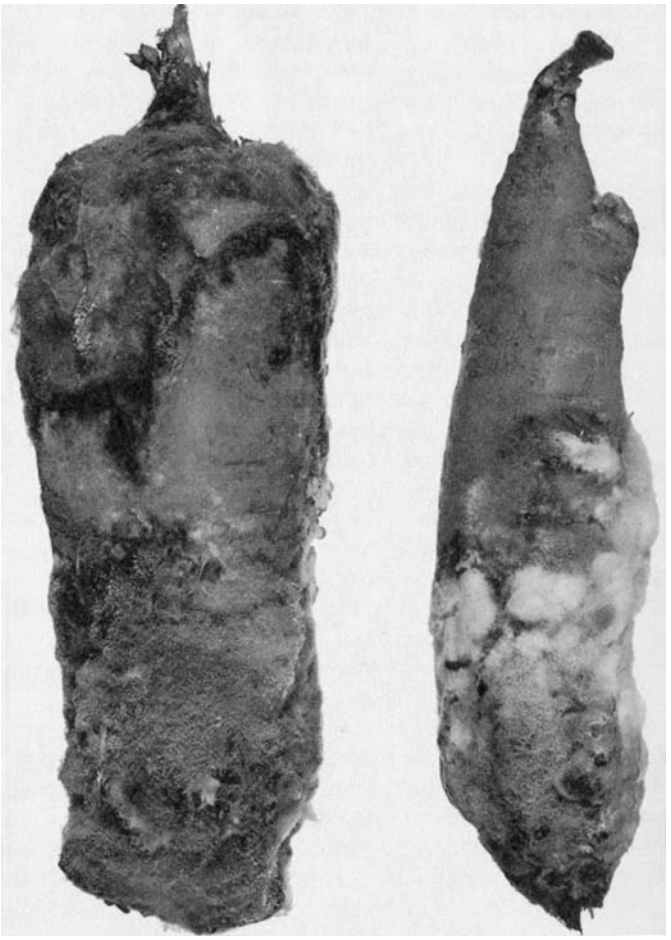

Figure 3.46 Storage Rot on Carrot

Ceratocystis fimbriata (*Endoconidiophora fimbriata*). **Sweet Potato Black Rot**, found wherever sweetpotatoes are grown, most destructive in storage but present also in seedbed and field. Round, blackish spots extend into vascular ring or deeper; sprouts are sickly with black cankers below ground or are killed. The fungus winters in storage houses, on wild morning-glory and other weeds near the field and in soil, where it remains viable for several years. Spores are spread by the sweetpotato weevil and in wash water if potatoes are washed before storing. This fungus also infects *Jacquemontia*.

Control. Standard treatment has been disinfection of planting stock in a solution of borax. Using pulled sprouts provides plants free from black rot. Plan a 4-year rotation; sort carefully before storage; cure quickly at high temperature and humidity. Yellow Jersey is highly susceptible; some varieties are quite resistant.

A strain of this fungus is reported causing **Black Cane Rot** in propagating bed of *Syngonium auritum* (*Philodendron trifoliatum*) in a California nursery. Brown to black water-soaked girdling cankers, often on parts in contact with the soil, cause yellowing and death of foliage. The fungus can be eradicated by treating canes with hot water, 120°F for 30 minutes.

Ceratocystis wageneri (see *Ophiostoma wageneri*). **Root Rot** of lodgepole pine and ponderosa pine.

Ophiostoma wageneri (formerly *Ceratocystis wageneri*). **Root Rot** of lodgepole pine and ponderosa pine.

Apostrasseria (Ceuthospora)

Deuteromycetes, Coelomycetes

Pycnidia in a valsoid stroma; conidia oblong to bacillar, extruded in tendrils; conidiophores obsolete or none.

Apostrasseria lunata (formerly *Ceuthospora lunata*). **Black Rot** of cranberry, developing in berries after picking. The fruit turns dark and soft. The disease is more important in Washington and Oregon. Spraying for other cranberry diseases largely controls this rot. Pick berries when dry; avoid bruises; keep them cool.

Ceuthospora lunata (see *Apostrasseria lunata*). **Black Rot** of cranberry, developing in berries after picking.

Chalara (Chalaropsis)

► Molds.

Chalara thielaviopsis (formerly *Chalaropsis thielaviopsis*). **Root Rot** on poinsettia.

Chalaropsis thielaviopsis (see *Chalara thielaviopsis*). **Root Rot** on poinsettia.

Armillaria (Clitocybe)

Basidiomycetes, Agaricales

One of the mushrooms, with gills typically decurrent (running down the stem), cap homogenous and confluent with fleshy stripe, which has neither ring nor cup; spores white or very lightly colored.

Armillaria tabescens (formerly *Clitocybe monadelpha*). On privet, apple.
Armillaria tabescens (formerly *Clitocybe tabescens*). **Mushroom Root Rot**, **Clitocybe Root Rot** of citrus, pecan and other fruits and many ornamentals. This root rot is as devastating in Florida as Armillaria rot is in California and very similar (some say the pathogen is identical). It is important in the decline of citrus groves, on orange, grapefruit, lemon, tangerine and lime on rough lemon stock; is very destructive to Australian-pine (*Casuarina*); and has been reported on more than 200 species in 59 plant families, including *Acalypha*, avocado, arborvitae, apricot, camellia, castor-bean, cherry-laurel, crape-myrtle, cotoneaster, cypress, dogwood, *Eugenia*, eucalyptus, grape, guava, glorybush, *Hamelia*, holly, *Ligustrum*, juniper, jasmine, loquat, oleander, poinciana, pomegranate, pear, *Parkinsonia*, rose, viburnum and wax-myrtle. In recent years Clitocybe root rot has become economically important on Georgia peach trees and has killed many lychee trees in Florida. It is said to account for 75% of rose mortality in some sections.
Symptoms of decline do not ordinarily develop until the pathogen has been working a number of years and has killed a large part of the root system. Often mushrooms are present at the base of trees before the tops show more than a slight yellowing or lack of vigor; but if soil is removed from the root crown, many lateral roots are found dead, and often the taproot is also gone. Infection starts at some point on the lateral roots, spreads to the base of the tree, and then to other roots. Sometimes there is gumming at the crown extending upward on the trunk. Mycelial fans or sheets are present between bark and wood; the clusters of mushrooms developing at the base are similar to those of *Armillaria*, but the black shoestring rhizomorphs are lacking. Instead, there are sometimes black, hard stromatic outgrowths from fissures in bark of infected roots. The fruiting clusters develop in fall, from mid-September to December. The caps are light tan to honey-colored, 2 to 3 1/2 inches in diameter. The rot is most prevalent on land cleared of oaks and other hardwoods, also on sandy, well-drained land subject to drought.

Control. Citrus trees on sour orange stock are quite resistant. Surgical treatment for fruits and ornamental trees is often quite successful. Remove the soil at least 2 or 3 feet from the trunk, working carefully to avoid injuring healthy roots. Cut off all dead roots, flush with the root crown and remove any infected oak or foreign roots in the vicinity. Cut out dead and infected bark at the root crown or the base of the trunk, being sure to collect all chips (on heavy paper placed under exposed roots) for burning. Paint all exposed surfaces with a pruning wound compound and fill in partially, disinfesting the soil with bordeaux mixture. The root crown can be left exposed to aeration and drying or, if too large a proportion of the root system has been lost, new roots can be stimulated by mounding the soil around the base to a height of several inches above the partial girdle. The new roots will come from callus formed at the margin of living bark.
Trenches 2 or 3 feet deep will aid in preventing spread to healthy trees. Fallow soil can be treated with carbon disulfide; ►*Armillaria mellea*.
Clitocybe monadelpha (see *Armillaria tabescens*). On privet, apple.
Clitocybe tabescens (see *Armillaria tabescens*). **Mushroom Root Rot**, **Clitocybe Root Rot** of citrus, pecan and other fruits and many ornamentals.

Colletotrichum

►Anthracnose.

Colletotrichum acutatum. **Bitter Rot** of apple fruit; fruit rot of grape.
Colletotrichum capsici. **Ripe Rot** of pepper, **Boll Rot** of Cotton.
Colletotrichum circinans. **Onion Smudge**, surface rot, also on shallot, garlic and leek. Bulb or neck has a dark green or black smudge, often covered with stiff bristles of the acervuli of the fungus. Smudge is more prominent in white onions; it is confined to the neck of colored bulbs. The fungus winters on mature onions, on sets or in soil. It develops in the field at a fairly high temperature and soil moisture with most of the damage just before harvest. Cure rapidly after harvest; rotate crops; clean up debris; change to colored onions if the rot is too serious on white.
Colletotrichum coccodes. **Root Rot** and **Wilt** of greenhouse tomato.
Colletotrichum gloeosporioides. **Fruit Rot** of grape and pepper.
Colletotrichum gloeosporioides (formerly *Colletotrichum nigrum*). **Fruit Rot** of pepper, probably general on pepper in South and East. The fun-

gus is a wound parasite on pepper pods. The spots are irregular, indefinite, depressed, blackish. Numerous acervuli with stout setae are scattered over spots.

Colletotrichum lilii. **Black Scale Rot** of Easter lily, **Brown Scale**. First noticed in Louisiana in 1937, the rot immediately threatened the lily industry in that section. Bulbs are brown to nearly black when dug, with outer scales most affected. Young lesions start as irregular light brown areas, then become black and sunken owing to collapse of epidermal cells and subepidermal layers. Oldest lesions are nearly black, with tissue dry and shriveled. Stems and roots are not affected. The acervuli are small, gregarious, with many dark brown setae and continuous hyaline conidia.

Colletotrichum nigrum (see *Colletotrichum gloeosporioides*). **Fruit Rot** of pepper, probably general on pepper in South and East. The fungus is a wound parasite on pepper pods. The spots are irregular, indefinite, depressed, blackish. Numerous acervuli with stout setae are scattered over spots.

Frammulina (Collybia)

Basidiomycetes, Agaricales

Margin of young cap turned in; gills not decurrent; stipe central; no annulus or volva; spores white or light; causing wood rots.

Collybia velutipes (see *Frammulina velutipes*). **Heart Rot**, **White Sapwood Rot** of hardwoods.

Frammulina velutipes (formerly *Collybia velutipes*). **Heart Rot**, **White Sapwood Rot** of hardwoods. The fungus is a small toadstool with central stem, base covered with dark brown velvety hairs, cap yellowish or brownish. The disease is a soft spongy white rot of sapwood of living hardwoods, particularly basswood, horse-chestnut, American elm and on catalpa. The toadstools are formed in clusters at wounds.

Coniophora

Basidiomycetes, Aphyllophorales

Pileus resupinate, effuse; hymenium with one layer, cystidia lacking; spores dark; wood-destroying.

Coniophora puteana. **Brown Cubical Rot** of conifers and sometimes hardwoods – on slash, building timbers, and sometimes living trees. The crustlike fleshy fruiting bodies are a little over 2 inches in diameter, olive to brown with whitish margins and smooth to slightly waxy surface.
Coniophora corrugis (see *Cylindrobasidium corrugum*). **Sapwood Rot** of alpine fir.
Cylindrobasidium corrugum (formerly *Coniophora corrugis*). **Sapwood Rot** of alpine fir.

Coniella (Coniothyrium)

► Cankers.

Coniella diplodiella (formerly *Coniothyrium diplodiella*). **White Rot** of grapes, appearing spasmodically on grapes but not one of the more important diseases. Small pycnidia appear on outside of fruit cuticle as shiny, rosy points, also on leaves. Infection is usually through wounds. Spots on ripe grapes are grayish, with brown borders.
Coniothyrium diplodiella (see *Coniella diplodiella*). **White Rot** of grapes, appearing spasmodically on grapes but not one of the more important diseases.

Coprinus

Basidiomycetes, Agaricales

Inky cap mushrooms; hymenium lining gills; gills deliquesce into a black, inky liquid.

Coprinus urticicola. **Fruit Rot** of pear.

Corticium

Basidiomycetes, Aphyllophorales

Pileus resupinate, effuse; hymenium with one layer, cystidia lacking; spores hyaline. *Corticium vagum* and other species with a thin film of mycelium with short, broad cells on substratum have been transferred to *Pellicularia*. Species with cystidia have been placed in *Peniophora*. See also *Corticium* under Blights.

Butlerelfia eustacei (formerly *Corticium centrifugum*). **Fisheye Fruit Rot** of apple, generally distributed. A dry, spongy rot often following scab.

Corticium centrifugum (see *Butlerelfia eustacei*). **Fisheye Fruit Rot** of apple, generally distributed.
Corticium fuciforme (see *Laetisaria fuciformis*). **Pink Patch** of turf, red thread.
Corticium galactinum (see *Scytinostroma galactinum*). **White Root Rot** of apple, also recorded on blackberry, dewberry, wineberry, peach and many ornamentals – baptisia, dogwood, holly, flowering almond, flowering plum, iris, winter jasmine, kalmia, pearl bush, peony, spirea, sumac, viburnum and white campion.
Corticium radiosum (see *Vesiculomyces citrinus*). **White Butt Rot** on subalpine fir in Colorado.
Laetisaria fuciformis (formerly *Corticium fuciforme*). **Pink Patch** of turf; red thread. Grass is first water-soaked, then dead, in isolated patches, 2 to 15 inches in diameter, with pinkish red gelatinous strands of the fungus matting the blades together and growing into coral red horns, 1/8 to 2 inches long. These turn brittle, break into pieces to spread the pathogen. Velvet bent grasses are more susceptible than colonial and creeping bents. Cadmium compounds will control if applied as protectants before the disease appears.
Scytinostroma galactinum (formerly *Corticium galactinum*). **White Root Rot** of apple, also recorded on blackberry, dewberry, wineberry, peach and many ornamentals – baptisia, dogwood, holly, flowering almond, flowering plum, iris, winter jasmine, kalmia, pearl bush, peony, spirea, sumac, viburnum and white campion. The fungus also causes a root rot of white pine and a decay of firs, affecting also western white cedar and spruce. The disease starts at the collar or on larger roots and advances rapidly outward on smaller roots. The collar may be girdled and killed while distal portions are still alive. A dense weft of white mycelium covers roots and penetrates to wood, causing the white rot. The disease is prevalent on lands recently cleared of oaks.
Vesiculomyces citrinus (formerly *Corticium radiosum*). **White Butt Rot** on subalpine fir in Colorado.

Corynespora

► Leaf Spots.

Corynespora cassiicola. **Root Rot** on soybean.

Cryptochaete

Basidiomycetes, Aphyllophorales

Basidocarp cartilaginous or coriaceous, erumpent, at first tuberculiform; gloecystidia yellowish or hyaline; cystidia present or lacking; spores hyaline, curved-cylindrical to allantoid, smooth.

Cryptochaete (Corticium) polygonia (see *Peniophora polygonia*). **White Rot** on aspen in Colorado.
Peniophora polygonia (formerly *Cryptochaete* (*Corticium*) *polygonia*). **White Rot** on aspen in Colorado.

Cylindrocarpon

Deuteromycetes, Coelomycetes

Conidia on sporodochia; spores with several cells, like *Fusarium* but more nearly cylindrical with rounded ends; cosmopolitan in soil, occasionally pathogenic.

Cylindrocarpon liriodendri. **Root Rot** of tulip poplar.
Cylindrocarpon destructans. Sometimes listed as cause of Scale-Tip Rot of Easter lily in Pacific Northwest, but probably secondary. True cause of rot unknown.

Cylindrocladium

► Blights.

Cylindrocladium clavatum. **Root Rot** on Norfolk-island-pine.
Cylindrocladium crotalariae (Teleomorph, *Calonectria crotalariae*). **Cylindrocladium Black Rot** on peanut, and **Root Rot** on tulip tree and kiwi. Red crown rot; on soybean.
Cylindrocladium scoparium. **Root Rot** on peach and tulip-tree.
Cylindrocladium heptaseptatum. **Postharvest Decay** on leatherleaf fern.
Cylindrocladium pauciramosum. **Root and Crown Rot** on heath.
Cylindrocladium parasiticum. **Black Rot** of hoary-tick clover and on peanut.
Cylindrocladium pteridis. **Postharvest Decay** on leatherleaf fern.

Cylindrocladium scorparium. **Root Rot** on pine, sweet gum and tuliptree.

Daedalea

Basidiomycetes, Aphyllophorales

Pileus dimidiate to caplike and stipitate; pores waved, mazelike or somewhat resembling gills; without cystidia; hymenium labyrinthine.

Cerrena unicolor (formerly *Daedalea unicolor*). **Heart Rot**, **Canker** of maples and other living hardwoods, including alder, ailanthus, amelanchier, birch, chestnut and hackberry. Decayed wood is yellow at first, later white and soft. Conks are small, corky, often occuring in clusters, varying from brown to gray.

Daedalea confragosa (see *Daedaleopsis confragosa*). **White Mottled Wound Rot** of hardwoods, also on fir.

Daedalea quercina. **Brown Cubical Rot** of dead timber; **Heart Rot** of living trees in immediate vicinity of butt wounds, usually on oak, chestnut, sometimes on maple, birch and hickory. In advanced stages the wood is reduced to a yellow-brown friable mass, with a tendency to break into small cubes. Conks are corky and shelf-shaped, up to 7 inches wide, grayish to almost black with smooth upper surface and cream to brownish undersurface. Mouths are large, elongated, irregular. The conks are more or less perennial.

Daedalea unicolor (see *Cerrena unicolor*). **Heart Rot**, **Canker** of maples and other living hardwoods, including alder, ailanthus, amelanchier, birch, chestnut and hackberry.

Daedaleopsis confragosa (formerly *Daedalea confragosa*). **White Mottled Wound Rot** of hardwoods, also on fir. This is a white soft rot, a slash destroyer in eastern hardwood forests but sometimes on living trees, especially willows, near wounds. Annual leathery to rigid conks (sporophores) are shelf-shaped, up to 6 inches wide, and may occasionally encircle a small, dead stem. The upper surface is gray to brown, smooth, concentrically zoned. Mouths of tubes on undersurface are elongated, wavy in outline.

Daldinia

Ascomycetes, Xylariaceae

Perithecia in a globoid to pulvinate, concentrically zoned stroma, carbonaceous to leathery, 3 to 5 cm across; spores one-celled; dark.

Daldinia concentrica. **Wood Rot** of ash, beech, various hardwoods and occasionally citrus. There is a superficial white rot on dead parts of living trees. On English ash the decay is called calico wood and is strikingly marked with irregular brown to black bands. Stroma containing perithecia are hemispherical, black, carbonaceous.

Diaporthe

►Blights.

Diaporthe phaseolorum. **Sweetpotato Dry Rot**. If diseased potatoes are planted, the sprouts are affected, but the disease shows little in the field. The roots, infected at the stem end, continue to rot in storage. They are shrunken, often mummified, covered with papillae, which are pycnidia under the skin massed in a coal-black stroma. Optimum temperature for the fungus is 75° to 90°F. Use cool storage.

Diaporthe citri. **Phomopsis Stem End Rot**, **Melanose**, general on citrus; Stem Rot of mango. The rot on fruits is a leathery, pliable, buff to brown area at the button end. The melanose is a superficial marking of fruits with yellow or brown, scabby, waxy dots or crusts, on leaves, twigs and fruit, often in streaks. On lemon trees, especially variety Eureka, there is a condition known as decorticosis or shell bark. The outer bark dies, loosens, peels off in longitudinal strips. New bark forms below this, and the tree may recover only to develop the disease again in 4 or 5 years. Some leaves and twigs die; the fungus winters in dead wood.

Control. A single copper spray, bordeaux or a neutral copper, applied within 1 to 3 weeks after fruit is set, controls melanose. Copper applied in summer induces excessive cork formation in the melanose lesions, a condition known as star melanose. Applied early, it is noninjurious.

Diaporthe phaseolorum. **Fruit Rot** of pepper and tomato, also pod blight of lima bean. ►Blights.

Dichotomophthora

►Cankers.

Dichotomophthora portulacae. **Black Stem Rot** on common purslane.

Diplodia

► Blights.

Diplodia natalensis (see *Lasiodiplodia theobromae*). **Diplodia Collar** and **Root Rot**, **Fruit Rot**, **Gummosis**, general on citrus, sometimes peach, mango and avocado.

Diplodia opuntia. **Cladode Rot** of cactus.

Diplodia phoenicum. **Leaf and Stalk Rot** of date palms, **Fruit Rot**. The disease is sometimes fatal to transplanted offshoots. Leaves decay and die prematurely; spores are produced in great abundance. Infection is through wounds. Remove diseased tissue as far as possible and apply copper-lime dust.

Diplodia pinastri. **Collar Rot** of pine.

Diplodia theobromae (see *Lasiodiplodia theobromae*). Sometimes considered a synonym of *D. natalensis*.

Diplodia tubericola (see *Lasiodiplodia theobromae*). **Java Black Rot**, general on sweetpotatoes, especially in the South.

Diplodia zeae (see *Stenocarpella maydis*). **Diplodia Corn Ear Rot**, **Root and Stalk Rot**, seedling blight.

Lasiodiplodia theobromae (formerly *Diplodia natalensis*). **Diplodia Collar and Root Rot**; **Fruit Rot**, **Gummosis**, general on citrus, sometimes peach, mango and avocado. On fruit, the rot resembles Phomopsis rot in being a leathery pliable decay of the stem end. It can be prevented by spraying with bordeaux mixture, adding 1% oil to check the increase in scale insects after the copper kills entomogenous fungi keeping them in check. The collar rot may girdle young trees and produce some gumming. Trees affected with root rot seldom recover and should be removed.

Lasiodiplodia theobromae (formerly *Diplodia theobromae*). Sometimes considered a synonym of *D. natalensis* but differentiated by pycnidia developed in a stroma instead of on a subiculum and by darker spores. Causing rots of tropical fruits, stem-end rot of avocado and collar rot of peanuts. The peanut rot appears in Georgia, Florida and Alabama. Runners and central stem are invaded; they are brown at first, then black with pycnidia.

Lasiodiplodia theobromae (formerly *Diplodia tubericola*). **Java Black Rot**, general on sweetpotatoes, especially in the South. So named because the first diseased specimens came from Java; this is strictly a storage rot. The inner part of the tuber is black and brittle; innumerable pycnidia are pro-

duced under the skin, giving it a pimply appearance. The potato is finally mummified. Use care in handling so skins are not broken or bruised; cure properly after harvest; have suitable temperature in the storage house.
Stenocarpella maydis (formerly *Diplodia zeae*). **Diplodia Corn Ear Rot, Root and Stalk Rot**, seedling blight. This is one of several fungi commonly causing ear rot in corn. The rot is dry, varying from a slight discoloration of kernels to complete rotting of the ear. Seedlings and inner stalks have a dry, brown decay. Another species (*D. macrospora*) is similar but less common, found in more humid, warmer regions. The rot is greater in smutted plants. Treat seed before planting with Spergon.

Diplodina

► Leaf Spots.

Diplodina persicae. **Fruit Rot** of peach, found in Louisiana in 1952, affecting stem and leaves as well as fruit. All varieties are susceptible.

Epicoccum

► Leaf Spots.

Epicoccum nigrum. **Postharvest Decay** on cantaloupe.

Echinodontium

Basidiomycetes, Aphyllophorales

Hymenium in the form of teeth with spiny serrate margins; pileus caplike to crustose.

Echinodontium tinctorium. The Indian paint fungus causes **Brown Stringy Rot, Heartwood Rot** of living conifers – balsam fir, hemlock, Engelmann spruce, larch, and Douglas-fir – chiefly in the West, often with large losses in forest stands. Light brown to tan spots are produced in heartwood accompanied by small radial burrows resembling insect galleries. Rusty streaks follow the grain. In older trees rot can extend entire length of heartwood and into roots. External signs of decay are hard, woody, hoof-shaped perennial conks, the upper surface dull black, cracked, the undersurface gray,

covered with coarse teeth, the interior rust are brick red with a pigment used by the Indians for paint. Even one fruiting body is indicative of extensive decay.

Polyporus (Favolus)

Basidiomycetes, Aphyllophorales

Pileus usually stipitate; lamellae forking irregularly to form elongate, rhomboidal pores.

Favolus alveolaris (see *Polyporus mori*). **Heart Rot** of hickory.
Polyporus mori (formerly *Favolus alveolaris*). **Heart Rot** of hickory.

Fomes

Basidiomycetes, Aphyllophorales

Pileus woody, perennial, with tubes in layers; common cause of wood decay. Spores hyaline to brown to nearly black.

Fomes annosus (see *Heterobasidion annosum*). **Heart Rot**, **Root and Butt Rot**, **Spongy Sap Rot** of conifers, sometimes hardwoods; also **Root Rot** on juniper and rhododendron.
Fomes applanatus. ▶ *Ganoderma applanatum*.
Fomes connatus. **White Spongy Rot** of heartwood of living hardwoods, most prevalent on maples, especially red and sugar maples. Entrance is through wounds or branch stubs, but fruiting is usually on basal stems or scars. Conks appear annually but are perennial, small, less than 6 inches wide, hoof-shaped, corky to woody, white to yellowish, the upper surface covered with moss or algal growth. There is usually a limited area of decay.
Fomes everhartii (see *Phellinus everhartii*). **Yellow Flaky Heart Rot** of living hardwoods, including birch and beech and especially oaks.
Fomes fomentarius. **White Mottled Rot** of birch, beech, poplar, maple, and other hardwoods. This fungus mostly decays dead timber; sometimes it attacks living trees. The wood is brownish, firm in early stages of decay, but in advanced stages is yellowish white, soft, spongy, with narrow dark zone lines and small radial cracks filled with yellow mycelium, giving a mottled effect. Decay starts in upper part of the bole and progresses downward. Conks are profuse on dead trees. They are hard, perennial, hoof-shaped, up to 8 inches wide, with a smooth concentrically zoned upper surface, gray to

brown undersurface. The interior is brown, punky, with tubes encrusted with white.

Fomes fraxinophilus (see *Perenniporia fraxinophila*). **White Mottled Rot** of ash, a heartwood rot most common on white ash, also on green ash and willow.

Fomes igniarius (see *Phellinus igniarius*). **White Spongy Rot**, **White Trunk Rot**, **Heart Rot**, on a wide variety of hardwoods but not on conifers.

Fomes officinalis (**Fomitopsis officinalis**) (see *Fomitopsis officinalis*). **Brown Trunk Rot** of conifers infecting heartwood of living larch and other trees.

Fomes pini (**Trametes pini**) (see *Phellinus pini*). **Red Ring Rot**, white pocket rot, of conifers, especially Douglas-fir, larch, pine and spruce, causing heavy forest losses.

Fomes pinicola (see *Fomitopsis pinicola*). **Brown Crumbly Rot** of many conifers and some hardwoods – maple, birch, beech, hickory, peach – sually on dead trees, occasionally in heartwood of living trees.

Fomes rimosus (see *Phellinus robiniae*). **Heart Rot** on locust.

Fomes robustus (see *Phellinus robustus*). **Heart Rot** of cacti and other desert plants; of oak, fir, juniper, in different strains.

Fomes roseus (see *Fomitopsis rosea*). **Brown Pocket Rot**, cubical rot of heartwood of living conifers, particularly Douglas-fir.

Fomitopsis officinalis (formerly *Fomes officinalis* (*Fomitopsis officinalis*)). **Brown Trunk Rot** of conifers infecting heartwood of living larch and other trees. Intensely white spore surface; very bitter, known as the quinine fungus.

Fomitopsis pinicola (formerly *Fomes pinicola*). **Brown Crumbly Rot** of many conifers and some hardwoods – maple, birch, beech, hickory, peach – ually on dead trees, occasionally in heartwood of living trees. Sporophores are shelf- to hoof-shaped, 2 to 10 inches across, sometimes up to 2 feet, upper surface gray to black, often with a red margin, underside white to yellow when fresh.

Fomitopsis rosea (formerly *Fomes roseus*). **Brown Pocket Rot**, cubical rot of heartwood of living conifers, particularly Douglas-fir. Decay originates in upper part of bole. Wood is yellow to reddish brown, soft, breaking into irregular cubes. Woody bracket conks, up to 6 inches wide, have black tops and rose undersurface. Infection is through dead branch stubs and broken tree tops.

Heterobasidion annosum (formerly *Fomes annosus*). **Heart Rot**, **Root and Butt Rot**, **Spongy Sap Rot** of conifers, sometimes hardwoods; also

Root Rot on juniper and rhododendron. Infection is through wounds. Tissue thin, mycelial felts are formed between bark and wood, which is pinkish to violet in incipient states. In advanced stages white pockets are formed in wood. Perennial conks are bracket-shaped to flat layers, upper surface zonate, light to dark grayish brown, undersurface beige with small pores. Infection is sometimes through dead roots from mycelium growing through soil, sometimes by spores washed by rain or carried by rodents.

Perenniporia fraxinophila (formerly *Fomes fraxinophilus*). **White Mottled Rot** of ash, a heartwood rot most common on white ash, also on green ash and willow. Conks are up to a foot wide, with dark, rough upper surface, brownish underneath, appearing first when wood has decayed only a short distance. Infection is usually through branch stubs.

Phellinus everhartii (formerly *Fomes everhartii*). **Yellow Flaky Heart Rot** of living hardwoods, including birch and beech and especially oaks. Infection is usually limited to the lower trunk, and the flaky character is because the decay is more rapid between rays. There are narrow, dark brown zone lines. Gnarled swellings on the trunk indicate sapwood invasion. The conks are perennial, hard, woody, shelf-shaped, up to a foot wide, with the yellow-brown upper surface becoming black, charred, rough, concentrically grooved with age. The undersurface is reddish brown.

Phellinus ingiarius (formerly *Fomes igniarius* (*Phellinus igniarius*)). **White Spongy Rot**, white trunk rot, heart rot, on a wide variety of hardwoods but not on conifers. Aspen and birch are particularly susceptible. Decay is mostly confined to heartwood, but in yellow birch living sapwood is killed, causing cankers on the trunk. In an advanced stage the decay is soft, whitish, with fine black lines running through it. The conks are perennial, hard, woody, thick, usually hoof-shaped, up to 8 inches wide, the upper surface gray to black, becoming rough and cracked with age; undersurface is brown and the interior rusty brown with many layers of tubes, the oldest stuffed with white. Infection is through branch stubs and open wounds. A single conk may indicate 15 linear feet of rot in heartwood.

Phellinus pini (formerly *Fomes pini* (*Trametes pini*)). **Red Ring Rot**, white pocket rot, of conifers, especially Douglas-fir, larch, pine and spruce, causing heavy forest losses. Decay starts as a purplish or red discoloration of the heartwood, but in an advanced stage there are many soft, white fibrous pockets separated by sound wood. Sporophores vary from shelf- to bracket- to hoof-shaped, averaging 4 to 8 inches across, rough gray to brownish black with light brown margin on upper surface and gray to brown underneath.

Tube mouths are circular to irregular. On living trees conks are formed at knots or branch stubs.

Phellinus robiniae (formerly *Fomes rimosus*) **Heart Rot** on locust.

Phellinus robustus (formerly *Fomes robustus*). **Heart Rot** of cacti and other desert plants; of oak, fir, juniper, in different strains. Context of sporophores bright yellow-brown; spores hyaline.

Fusarium

Deuteromycetes, Coelomycetes

Mycelium and spores generally bright in color. Macroconidia fusoid-curved, septate, on branched conidia in slimy masses, sporodochia; smaller microconidia with one or two cells; resting spores, chlamydospores, common. Teleomorph state when known usually in Hypocreales, *Nectria* or *Gibberella*. Cause of many important rots, wilts, and yellows diseases. Classification difficult, with different systems and synonyms, many forms and races. (see Fig. 3.47)

Fusarium acuminatum. **Fruit Rot** of squash and pumpkin.

Fusarium avenaceum. **Crown Rot** of Eustoma. Associated with cereal diseases, fruit and storage rots, but now included in *F. roseum* by many pathologists. **Fruit Rot** of squash and pumpkins.

Fusarium culmorum. Also on cereals, included in *F. roseum* by many pathologists. **Fruit Rot** of squash and pumpkins, also **Root and Basal Rot** of leak.

Fusarium equiseti. **Fruit Rot** of squash and pumpkin.

Fusarium moniliforme (Teleomorph, *Gibberella fujikuroi*). **Ripe Rot** of figs, carried by the pollinating fig wasp; **Root, Stalk, Pink Kernel Rot** of corn. The rotted kernels are pink to reddish brown; the stalks have brown lesions, may break over or ripen prematurely.

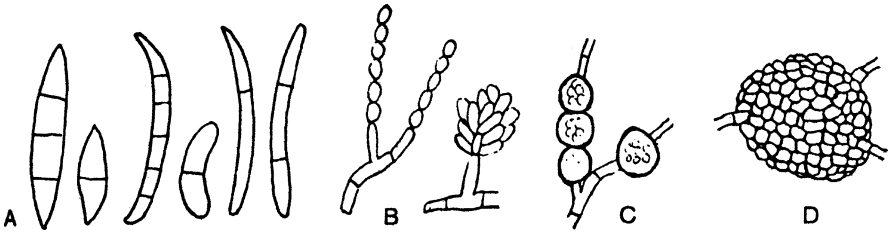

Figure 3.47 Forms of *Fusarium*. **A** septate macroconidia; **B** micoconidia in chains or a head; **C** clamydospores; **D** sclerotium

Fusarium oxysporum. Reported as causing a new disease of soybean in Missouri and Iowa. Root rot, with rapid wilting and drying of leaves; most severe on seedlings.

Fusarium oxysporum. **Root Rot** on apple and sage; tomato hypocotyl rot on sugar pine, red and white firs; stem rot on zygocactus; and rot of stone plant. This pathogen may also be seedborne and pathogenic on Douglas-fir. Root and crown rot; of leafy spurge.

Fusarium oxysporum. **Iris Basal Rot** on bulbous varieties of iris. Plants fail to emerge, or turn yellow, wilt and die. Roots are few or none. The bulb is infected at the base, which shrinks; the husk adheres firmly, sometimes with a white or reddish mass of mycelium. The rot is more serious in warm climates and on yellow rather then blue varieties. De Wit is very susceptible; Wedgewood is quite resistant.

Control. Avoid bruising bulbs in digging; sort and discard diseased bulbs right after digging; dry bulbs rapidly.

Fusarium oxysporum. **Tulip Basal Rot**. Leaves growing from diseased bulbs turn red, wilt and die; roots are few or none. Bases of bulbs have a rather firm rot with white or pink felty masses of spores. The diseased area usually turns chalky. This is primarily a storage disease in bulb sheds and warehouses.

Fusarium oxysporum f. sp. **batatas**. **Sweetpotato Stem Rot**, a widespread field disease, destroying more than 50% of plants in some fields. This fungus also infects *Jacquemontia*. The stem rot is conspicuous about 2 weeks after sprouts are set. Sprouts are yellow or dead, and the vines brown or black, often split near the ground. Some plants develop new roots above the decayed section and so survive. Sweetpotatoes from infected plants are small, decayed at the stem end, with vascular tissues brown. The fungi winter in stored roots and can live indefinitely in soil. Varieties Big Stem Jersey, Little Stem Jersey, Maryland Golden and Nancy Hall are very susceptible; Porto Rico is intermediate; Southern Queen, Triumph, and Yellow Strassburg are quite resistant.

Fusarium oxysporum f. sp. **cepae**. **Bulb Rot**, **Basal Rot** of onion, shallot and garlic. In the field there is progressive yellowing and dying back from tips, the roots commonly turning pink and gradually decaying. The rot is often associated with wounds of maggots and other insects. In storage the rot is most active at room temperature or above.

Fusarium oxysporum f. sp. **chrysanthemi**. **Fusarium Wilt** of chrysanthemum.

Fusarium oxysporum f. sp. **gladioli** (*F. orthoceras* var. *gladioli*). **Fusarium Brown Rot**, **Yellows** of gladiolus, a major disease in some sections. Most infection takes place in the field, but subsequent decay appears in storage. Corm lesions are first small, reddish brown, more often on lower half of corm. They enlarge in storage to irregular to circular, sometimes zonate brown areas, which do not infrequently advance until the whole corm is a hard, dry, brownish black mummy. Infection comes from old corms, the fungus penetrating through the basal plate and the center of the new corm. The latter may be entirely decayed in storage, with the fungus advancing from the center to the outside, causing brown to black surface lesions.

Symptoms of yellows, a vascular disease, include bending of young leaf stalks, cupping of leaf stalks in older plants, crooked flower stems, often greener than normal and a curving of growth away from the side of the corm showing rot. There is gradual yellowing and dying of foliage, starting with the oldest leaves. Picardy and Spotlight varieties are particularly susceptible. Nitrogenous fertilizers and manures, especially where phosphorus is low, increase corm rot.

Control. Cure immediately after digging at 95°F to develop wound periderm and cuticle resistant to the fungus; use resistant varieties where possible or a 3- to 4-year rotation.

Fusarium oxysporum f. sp. **lilii**. **Basal Rot** of lily, on bulbs, roots, stems of garden and native lilies; **Corm Rot** of crocus, also on freesia and cactus (*Cereus*). A chocolate rot at base of scales next to the basal plate progresses until the scales fall away. The disease is more destructive to Madonna and some other garden lilies; it is seldom a problem with Easter lilies grown in the Northwest. Keep bulbs cool in storage, and plant in cool soil. Infection comes from contaminated soil as well as diseased bulbs.

Fusarium oxysporum f. sp. **narcissi** (*F. bulbigenum*). **Narcissus Basal Rot**, general on hardy varieties, rare on polyanthus varieties. Rot begins at the root plate at base of bulbs and spreads through central portions first, extension of the rot being more rapid in affected scales than across to adjacent healthy scales. Rotted tissue is chocolate or purplish brown, the mycelium a delicate weft of white or pink threads. The rot is dry, spongy, with little external evidence; it is primarily a storage or transit disease, but it may occur in the field late in the season. When lightly infected bulbs are planted, there is no root development, and plants are stunted. Basal rot is spread in hot-water treatment for nematodes. It is more prevalent where soil temperatures

are above 65°F and on large trumpet varieties. Golden Harvest is much more susceptible than King Alfred.
Control. Discard all bulbs showing rot, or that are soft when pressed; if disease has occurred previously, plant in a new location.
Fusarium oxysporum f. sp. **radicis-lycopersici**. **Root and Crown Rot** of tomato.
Fusarium oxysporum var. **redolens**. **Root Lesions** of pine.
Fusarium poae. **Carnation Bud Rot**, **Silver Spike Disease** of bluegrass. The interior of carnation buds is brown or pink, decayed, moldy and often infested with grass mites, which have introduced the spores. The disease is favored by excessive dampness. Pick and destroy diseased buds; control mites.
On bent grasses, fescues and especially Kentucky bluegrass, seed heads wither before they are fully expanded, appearing silvery. Seeds are aborted, and in moist weather copious mycelium grows from decayed areas in culms. The pathogen is disseminated and grass inoculated by the grass mite (*Siteroptes graminum*). Burning over dead grass is a practical means of control.
Fusarium proliferatum. **Root Rot** and **Stem Wilt** on asparagus in CT. **Root Rot** and **Crown Rot** of clovers and leafy spurge, **Bulb Rot** of onions.
Fusarium roseum. **Peppermint Root** and **Rhizome Rot**. Reported from Oregon as part of a complex with *Rhizoctonia solani* and *Pythium* sp. Necrotic lesions girdle rhizomes; new shoots damp-off. Fall-plowed mint gave stronger stands. This pathogen also causes seedling stem rot on Douglas-fir.
Fusarium cerealis. **Stem Rot** of carnation and cereals. Roots and stems of cuttings and young plants rot; in older stock the diseased tissue turns brownish red or crimson. Infection is only through injured, weak or old tissue.
Fusarium semitectum. **Corky Dry Rot** on cantaloupe.
Fusarium solani. **Tuber Rot** on caladium and **Stem Rot** on chrysanthemum, Fraser fir, Douglas-fir, dieffenbachia (cutting rot), and sweetpotato (root rot); shefflera is susceptible with no symptoms. Root rot; this pathogen also causes root rot of apple. **Root and Crown Rot** of leafy spurge.
Fusarium solani (Teleomorph, *Nectria haematococca*). **Stem Rot** and **Wilt** of *Exacum*.
Fusarium solani f. sp. **cucurbitae** (Teleomorph, *Hypomyces solani*). **Fusarium Root Rot** of cucurbits, primarily pumpkin and squash, occasionally muskmelon, watermelon and cucumber. The fungus usually girdles the plant at ground level with a soft dark decay, resulting in a striking wilt of the entire vine. Fruits on the ground may be rotted and the fungus carried on seed to

infest clean soil. Do not plant cucurbits in land known to be contaminated.
Fusarium solani f. sp.**phaseoli**. **Dry Root Rot** of bean and lima bean, common but most important in New York, Idaho and other areas intensively cropped for many years. Indefinite reddish lesions or streaks on taproot and subterranean stem turn dark brown to black. Lateral roots are reduced and plants stunted. This is a late season disease favored by warm soil. The fungus winters in crop refuse and soil and may be carried in dust on seed. The best control is a long rotation between crops.
Fusarium solani f. sp. **pisi**. **Root Rot** on chick-pea, spruce, pine, fir, and hemlock.
Fusarium subgutinans. **Collar Rot** and **Foliar Blight** on Chinese evergreen.
Fusarium sp. **Root and Seed Rot** of bird-of-paradise (*Strelitizia*), part of a fungus complex. Controlled by treating seed in hot water, 135°F for 30 minutes, and immediately cooling in cold water and treating planting medium with methyl bromide or steam.
Fusarium sp. **Dill Root Rot**, **Wilt**, discovered in Ohio in 1949. Symptoms include browning of roots, necrosis of vascular system, yellowing, wilting and death. Young plants are most susceptible. Seed treatment did not give satisfactory control.
Fusarium sp. **Root Rot** of sweet peas, reported as prevalent in Montana. Plants turn yellow when in bloom with necrosis of vascular system which leads to drying up of plant.

Gaeumannomyces

Gaeumannomyces graminis var. **graminis**. **Blight** of centipede grass and Bermudagrass. Root rot; of St. Augustinegrass. Leaf yellowing and root mass reduction; of Zoysia.

Ganoderma

Basidiomycetes, Aphyllophorales

Differing from *Fomes* in having spores truncated at one end and two-layered, the spines of the brown endospore projecting into hyaline exospore. Sporophore has a hard crust, formed by a layer of thick-walled, elongated cells.

Ganoderma applanatum (Syn. *Fomes applanatus*). **White Mottle Rot**, widely distributed on hardwoods, maple, beech, alder, acacia, birch, horsechestnut, hawthorn and hickory, and sometimes on conifers. The rot is ordinarily on dead timber, but the fungus can attack living trees through wounds and destroy heartwood for a few feet. In early stages the wood is somewhat bleached, surrounded by a dark brown band. This shelf fungus is called artists' conk because the white undersurface immediately turns brown when bruised and can be used for writing or etching pictures. The upper surface is smooth, zoned, gray or gray-black; up to 2 feet wide.
Ganoderma curtisii (see *Ganoderma lucidum*). Perennial, with several layers of pores.
Ganoderma lucidum (formerly *Ganoderma curtisii*). Perennial, with several layers of pores.
Ganoderma lucidum (Syn. Polyporus lucidus). The varnish or lacquer fungus causes **Heart Rot** of eastern hardwoods and conifers, especially hemlock, reported also on boxwood, hackberry, sassafras, maples and citrus. This fungus may be an important facultative parasite on city shade trees. The rot is white, spongy, with black spots scattered throughout. The conks are annual, with a reddish, shiny, lacquered upper surface and a short, thick lateral stalk; common on logs, stumps, standing or fallen trees.
Ganoderma zonatum. **Butt Rot** of queen palms, Florida.
Ganoderma zonatum. On mesquite, in Texas.

Greeneria

Deuteromycetes, Coelomycetes

Greeneria uvicola. **Bitter Rot** of grape.

Gibberella

► Blights.

Gibberella zeae (Anamorph, *Fusarium graminearum*). **Corn Root Rot**, **Stalk Rot**, **Ear Rot**, also **Fusarium Head Blight** or **Scab** of cereals and grasses. Corn is attacked at all ages, with both roots and kernels rotted. Conidia are pinkish in mass; black perithecia are numerous on overwintered corn

stalks and residues. Hybrid corn with loose husks exposing the ear tip or varieties with upright ears retaining water are more apt to be infected. Rotation and clean plowing aid in control.

Gilbertella

Zygomycetes, Mucorales

Gilbertella persicaria. **Fruit Rot** on peach.

Gloeosporium

► Anthracnose.

Colletotrichum gloeosporioides (formerly *Gloeosporium foliicolum*). (*Glomerella cingulata*). **Fruit Rot** on citrus fruits.
Gloeosporium foliicolum (see *Colletotrichum gloeosporioides*). (*Glomerella cingulata*). **Fruit Rot** on citrus fruits.

Gloeotinia

Gloeotinia granigera (formerly *Gloeotinia temulenta*). **Blind Seed Rot** on grass.
Gloeotinia temulenta (see *Gloeotinia granigera*). **Blind Seed Rot** on grass.

Glomerella

► Anthracnose.

Glomerella cingulata. **Bitter Rot** of apple and pear, **Fruit Rot** of peach, also **Stem Rot**, **Canker**, **Dieback** of many fruits and ornamentals, Ripe Rot of grapes. Bitter rot is a late season disease of apple, often destructive in central and southern states. The fruits have light brown circular spots, which gradually enlarge; they cover rotting flesh, which has a bitter taste. Lesions become concave and have concentric rings of pink to dark spore pustules in sticky masses. Spores are splashed by rain or carried by flies and other

insects. Eventually apples turn into dry, shriveled mummies, in which the fungus overwinters and where the ascospore stage is produced. Large limbs have oval, roughened, sunken cankers. The disease is favored by hot muggy weather.

Apple varieties vary greatly in resistance, and some, like Yellow Newtown, are resistant to the canker but susceptible to fruit rotting. Varieties somewhat resistant include Delicious, Rome Beauty, Stayman Winesap, Winesap and York Imperial. Ripe rot starts on grapes as they mature and gives a bitter taste to the pulp. To control disease remove mummies from trees and prune out dead twigs and cankers.

Glomerella cingulata var. **vaccinii**. **Cranberry Bitter Rot**, a field and storage rot. A soft brownish yellow discoloration develops on fruit late in the season, most serious in a hot July and August.

Godronia

Ascomycetes, Helotiales

Apothecia coriacious, pitcher-shaped; spores filiform, hyaline.

Godronia cassandrae (*Fusicoccum putrefaciens*). **Cranberry End Rot**, general on cranberry, with the ascospore stage also found on dead branches of leatherleaf (*Cassandra*). The rot appears late, often after picking and packing, and is enhanced by injuries during harvesting and screening. It starts at either blossom or stem end of the berry; the fruit becomes soft and light-colored.

Godronia cassandrae f. sp. **vaccinii**. On blueberry.

Guignardia

► Blotch.

Botryosphaeria vaccinii (formerly *Guignardia vaccinii*). **Cranberry Early Rot**, **Scald**, **Blast**, general on cranberry and sometimes on huckleberry. All aerial plant parts are attacked, but the disease is more destructive to the fruit. Young fruit may blast and shrivel, but more often rot starts as a light-colored soft spot when fruit is half grown. The berry mummifies, turns black and is covered with small pycnidia. Leaves have reddish brown spots, sometimes drop prematurely.

Figure 3.48 Black Rot of Grapes

Guignardia bidwellii. **Black Rot** of grapes, widespread, principal cause of failure of European grapes in eastern United States, causing more loss than all other grape diseases combined. All parts of the vine are attacked. On leaves, reddish brown dead spots are sprinkled with black pycnidia. Rot starts on half-grown fruit as a pale spot, soon turning brown and involving the entire berry, which shrivels into a black wrinkled mummy, dropping or remaining in the cluster (see Fig. 3.48). Some berries shatter if attacked early. Ovoid conidia and sometimes microconidia (spermatia) are formed on leaves, berries and canes. Ascospores are produced in overwintered mummied berries. Primary infection in spring comes from either spore form.

Thecaphora deformans. **Seed Smut** of lupine.

Control. If mildew is also a problem, use a fixed copper. Cultivate in early spring so as to cover old mummies with soil and so eliminate that source of inoculum.

Guignardia vaccinii (see *Botryosphaeria vaccinii*). **Cranberry Early Rot**, **Scald**, **Blast**, general on cranberry and sometimes on huckleberry.

Helicobasidium

Basidiomycetes, Septobasidiales

An exposed cottony hymenium or fruiting layer; basidia transversely septate; spores coiled like a watch spring.

Helicobasidium corticioides. **Brown Pocket Rot** on subalpine fir, in Colorado.

Helicobasidium brebissonii (Anamorph, *Rhizoctonia crocorum*). **Violet Root Rot** of potato, sweetpotato, asparagus, beet, carrot and some ornamentals – ash, catalpa, chinaberry, crocus, elm, mulberry, parthenocissus and western soapberry. The fungus invades roots from the soil, turning them reddish or violet. The disease is confined to underground parts unless continuously wet weather allows the reddish-purple mycelium to grow up the stem. Small, darker sclerotia are embedded in this purplish mat, which turns brown with age.

Helminthosporium

► Blights.

Bipolaris cactivora (formerly *Helminthosporium cactivorum*). **Stem Rot** of cacti, **Basal** or **Top Rot** of seedling cacti, which turn into a shrunken brown mummy covered with spores. Initial symptoms are yellow lesions; rotting may be complete in 2 to 4 days.

Exserohilum turcicum (formerly *Helminthosporium turcicum*). **Crown Rot** of sweet corn, **Leaf Blight**. ► Blights.

Helminthosporium cactivorum (see *Bipolaris cactivora*). **Stem Rot** of cacti, **Basal** or **Top Rot** of seedling cacti.

Helminthosporium sesami. **Stem Rot** on sesame in Texas.

Helminthosporium turcicum (see *Exserohilum turcicum*). **Crown Rot** of sweet corn, **Leaf Blight**.

Hericium

Basidiomycetes, Aphyllophorales

Fleshy, branched or unbranched, with subulate spines long and pendant; spores spherical or subspherical, staining blue with iodine. Like *Hydnum* but sporophore formed on wood, not on the ground.

Hericium erinaceus (Syn. *Hydnum erinaceus*), hedgehog fungus. **White Heart Rot**, occasional on living oak, maple and other trees. The soft white spongy rot may entirely decompose the tissue, leaving large hollows lined with yellowish mycelium. Sporophores are annual; soft, white, browning with age, globular with a hairy top and long slender teeth on the lower surface.

Grandinia (Hyphodontia)

Basidiomycetes, Aphyllophorales

Grandinia granulosa (formerly *Hyphodontia aspera*). **Root and Butt Rot** of spruce.

Hypholoma

Basidimycetes, Agaricales

Margin of cap with a curtainlike veil; stipe with incomplete or vanishing ring; spores purple.

Hypholoma sublateritium. **Root Rot** of currant.

Idriella

Deuteromycetes, Hyphomycetes

Mycelium hyaline to brown; conidophores brown, simple, nonseptate, narrowed above, with prominent spore scars; conidia (sympodulospores) lunate to falcate, with pointed ends, produced in clusters near apex of the conidiophore; aleuriospores brown, several-celled.

Idriella lunata. **Root Rot** on strawberry.

Inonotus

Inonotus tomentosus (Syn. **Polyporus tomentosa**). **Root Rot** of spruce.

Irpex

Basidiomycetes, Aphyllophorales

Resupinate, effused-reflexed, or shelf-like; younger parts of hymenophore are poroid; with increasing age produce flattened teeth.

Irpex lacteus. Wood Rot and Decline of apple.

Gliocladium (Isaria)

Deuteromycetes, Hyphomycetes

Conidiophores equally distributed on a synnema, erect fascicle of hyphae; conidia hyaline, one-celled, ovoid; some species in insects.

Gliocladium roseum (formerly *Isaria clonostachoides*). Isaria Rot of tomato. Fruits are partly covered with cottony mycelium, white turning pink or orange and becoming granular, but rot remaining firm. Reported from around Washington, D.C.
Isaria clonostachoides (see *Gliocladium roseum*). Isaria Rot of tomato.

Kluyveromyces

Ascomycetes, Saccharomycetaceae

Kluyveromyces marxianus var. **marxianus**. Soft Rot of onion caused by a true yeast on bulbs.

Lasiodiplodia

Deuteromycetes, Coelomycetes

Lasiodiplodia theobromae. Collar Rot on peanut.

Lentinus

Basidiomycetes, Agaricales

Gills are notched or serrate at edge, decurrent, stipe often lateral or lacking cap, tough-fleshy to leathery; spores white.

Lentinus lepideus (see *Neolentinus lepideus*). **Scaly Cap**, causing a brown cubial rot of coniferous wood and sometimes decaying heartwood of living pines.
Lentinus tigrinus. **Sapwood Rot**, white mottled butt rot of living hardwoods, commonly associated with fire scars and one of the most important decay fungi in the Mississippi Delta. Fruiting body is white with cap depressed in center, more or less covered with blackish brown hairy scales, rarely developing on living trees.
Neolentinus lepideus (formerly *Lentinus lepideus*). **Scaly Cap**, causing a brown cubial rot of coniferous wood and sometimes decaying heartwood of living pines.

Lenzites

Basidiomycetes, Aphyllophorales

Pores elongated radially to resemble gills; pileus shelflike; woolly and zonate above.

Gloeophyllum sepiarium (formerly *Lenzites saepiaria*). **Timber Rot**, **Brown Pocket Rot**, usually of dead sapwood, occasionally a heart rot, rarely on living trees. This is the common destroyer of coniferous slash; it is found on telephone poles and other timber. Fruiting bodies are long narrow shelves coming from cracks, the upper surface a yellow red to dark reddish brown.
Lenzites betulina. **Heart Rot** of birch and cypress.
Lenzites saepiaria (see *Gloeophyllum sepiarum*). **Timber Rot**, **Brown Pocket Rot**, usually of dead sapwood, occasionally a heart rot, rarely on living trees.

Leptosphaeria

► Blights.

Leptosphaeria korrae. **Root and Crown Rot** of turf grasses (necrotic ring spot).

Macrophoma

► Cankers.

Macrophoma sp. **Fruit Rot** of grape.

Macrophomina

Deuteromycetes, Coelomycetes

Spores hyaline, one-celled, in pycnidia.

Macrophomina phaseolina (Anamorph, *Sclerotium* or *Rhizoctonia batati-cola*). **Charcoal Rot**, **Ashy Stem Blight**, on many plants in warm climates and sometimes in temperate zones. The name for the sterile stage comes from sweetpotato, and the term charcoal rot is used because the interior of the potato becomes jet black.

The fungus lives in the soil, is particularly prevalent in warm soils and attacks roots and stems of a varied list of hosts, including bean, lima bean, soybean, beet, corn, cowpea, cabbage, eggplant, garlic, gourds, pepper, strawberry and watermelon; also chrysanthemum, dahlia, garden mallow, mountain-laurel, marigold and zinnia. In most cases the pycnidial stage is not formed. The mycelium spreads through the soil, and very small black sclerotia are formed in great abundance on or in lower stems and roots. On beans, black sunken cankers appear just below the cotylendonary node, and the lesion may extend up the stem, ashy gray in the center. Stems may break over, or the growing point may be killed. In sweetpotatoes the disease is a storage rot, the tissue becoming a dark red-brown with the outer zone black from the formation of myriads of sclerotia. The decay is spongy, then hard, mummified. The fungus is spread in irrigation water, crop debris, imported soil and on seed.

Control. Use bean seed grown in western disease-free regions. Keep plants growing vigorously with proper food and water; practice general sanitation.

Macrophomina phaseolina. **Charcoal Rot** on soybean, sunflower, *Amaranthus, Euphorbia* spp., *Ipomea, Sonchus* and *Tidestrominia*; root rot on caper spurge.

Magnaporthe

Ascomycetes, Diaporthales

This is characterized by the production of perithecial ascocarps produced in a stroma of fungal and substrate tissues or directly from somatic hyphae on the substrate.

Magnaporthe poae. Summer patch and large brown patch on grass.

Melanconium

► Leaf Spots.

Greeneria uvicola (formerly *Melanconium fuligineum*). **Bitter Rot** of grapes, widespread but especially serious on Muscadine grapes in Georgia. Decayed berry pulp has a bitter taste; up to 30% of fruit is reduced to dry, hollow shells. Spray with bordeaux mixture three times at 14-day intervals beginning after fruit is set. The later sprays for black rot should control bitter rot.

Melanconium fuligineum (see *Greeneria uvicola*). **Bitter Rot** of grapes, widespread but especially serious on Muscadine grapes in Georgia.

Mycocentrospora

Deuteromycetes, Hyphomycetes

Mycocentrospora acerina. **Dry Rot** of carrot.

Monilinia

► Blights.

Monilinia fructicola (Syn. *Sclerotinia fructicola*). **Brown Rot** of stone fruits, blossom blight, general on peach, plum and cherry, also on apricot, almond, beach, plum, Japanese quince, and, rarely, apple and pear. The fungus is distinct from the species in Europe (*Sclerotinia fructigena*) causing brown rot of stone fruits and also a serious apple rot. In the United States, brown rot is our most destructive stone-fruit disease, causing an annual peach loss of over $5 million. *Monilina fructicola* is the usual causative agent east of the Rocky Mountains; *M. laxa* causes a similar rot and blossom blight on the Pacific Coast. See also ► Blights.

Flowers turn brown prematurely, rot in moist weather; the calyx cup is blackened, and the discoloration may extend down into the pedicels. Infrequently there is a leaf and twig blight; cankers are formed on the larger limbs, with exudation of gum. The fruit rot is the familiar stage seen in any backyard with a fruit tree and usually in baskets of peaches, plums or cherries purchased for preserving and held over to the next day. The rot starts as a small, circular brown spot but spreads rapidly to take in the entire fruit, with the rotted surface covered with gray to light brown spore tufts or cusions (sporodochia), sometimes in concentric rings (see Fig. 3.49). Conidia are formed in chains on the sporodochia. The fruit finally shrinks and mummifies and either falls to the ground or remains clinging to the tree.

The fungus and decayed tissue together form a stroma that acts as a sclerotium; in spring, if the mummy has been kept moist and partially or wholly covered with soil, cup-shaped brown apothecia are produced. Primary infection is from ascospores, forcibly ejected and carried up to blossoms by air currents or from a new crop of conidia formed on mummies hanging on trees. Secondary infection is from conidia wind-borne from blossom to blossom and later from fruit to fruit. Entrance is often through wounds made by the plum curculio, oriental fruit moth and other insects. Rotting and conidial production continue after picking.

The rot is favored by wet weather, conidia germinating only in a film of water. Acid soil is said to increase apothecial production from mummies on the ground. In a normal season reduction from blossom blight is not important because some thinning is advantageous; but if blossom blight is not prevented, inoculum is provided for the fruit rot that causes such enormous losses.

Control. Sanitary measures are important. In the small garden rake up and burn or bury deeply the fallen mummies; pick mummies from trees; cut out twigs showing gum; in summer remove infected fruit before conidia form. Standard control has been wettable sulfur sprays or sulfur dust, applied: every 3 or 4 days during bloom to control blossom blight; when shucks are falling; 2 or 3 weeks after shuck fall; and 2 to 4 weeks before fruit ripens. In some instances the newer organic fungicides are preferred to sulfur, and sometimes they are used with it. Control of the plum curculio is very important. For one or two trees in a home garden one of the all-purpose fruit sprays or dusts now available under various trade names may be satisfactory. Consult your county agent for the schedule right for your locality.

Monilinia laxa (Syn. *Sclerotinia laxa*). **Brown Rot**, green and ripe fruit rot, blossom blight, on almond, apple, apricot, cherry, peach, plum, pear, nec-

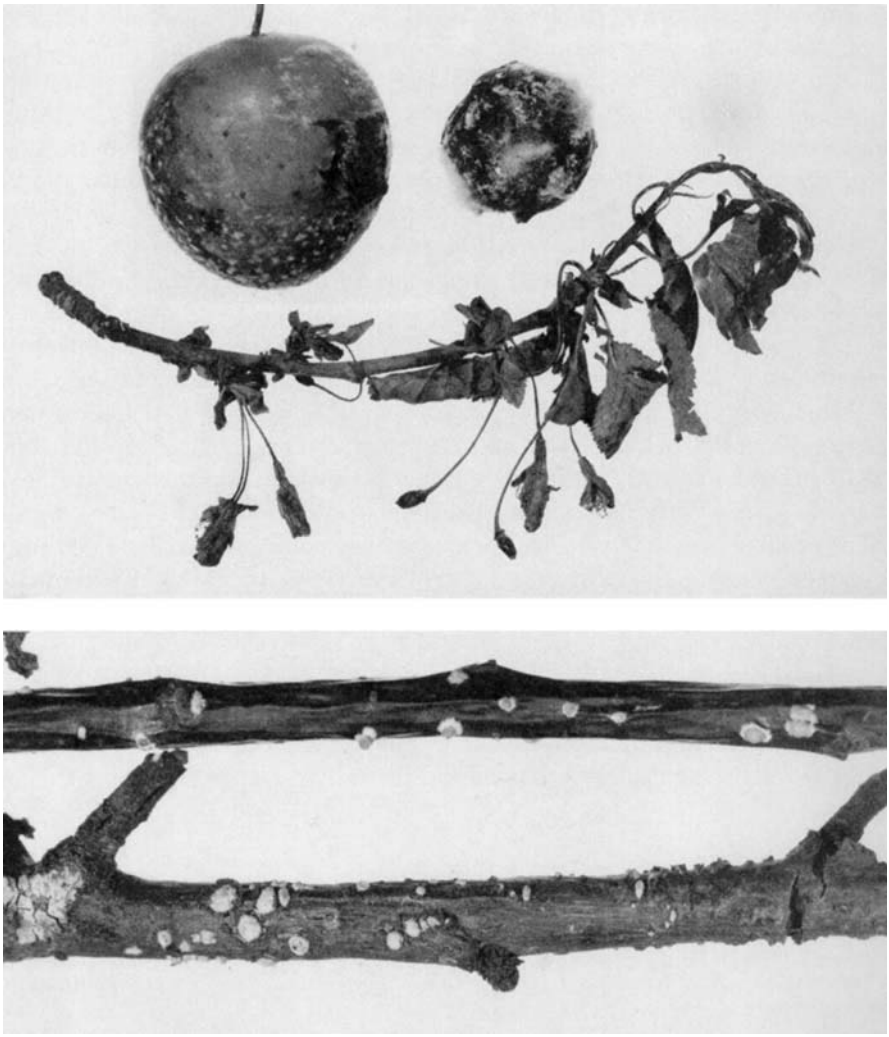

Figure 3.49 Brown Rot of Plums

tarine, quince and Japanese quince in Washington, Oregon and California; also reported from Wisconsin and Michigan. Although this disease is similar to that caused by *M. fructicola*, the blossom and twig blight phase is more important than the brown rot. Sulfur, which can be used in later sprays for most stone fruits, may injure apricots.

Monilinia oxycocci (Syn. *Sclerotinia oxycocci*). **Cranberry Hard Rot, Tip Blight** in Pacific Northwest and Wisconsin. Young growing tips wilt and

dry just before blossoming; grayish spores tufts are formed on tips. Fruit is attacked through blossoms or wounds. The berries are yellowish white, firm, leathery, cottony inside, turning dark and mummifying late in the season. The disease is too erratic to justify cost of regular spraying; clean harvest will prevent overwintering.

Monilinia urnula (Syn. *Sclerotinia vaccinii-corymbosi*). **Blueberry Brown Rot**, **Mummy Berry**, **Twig Blight** of high bush blueberry, similar to hard rot of cranberry. Varieties differ in susceptibility, with June and Rancocas often showing severe primary infection.

Monilochaetes

Deuteromycetes, Hyphomycetes

Conidiophores dark, erect, slender, usually simple; septate; conidia hyaline or becoming pigmented in age, borne singly at apex or produced in chains under conditions of high humidity.

Monilochaetes infuscans. **Root Rot** of weed species of genus *Ipomoea*.

Monosporascus

Ascomycetes, Sordariales

Monosporascus cannonballus. **Root Rot** on cantaloupe and watermelon.

Mucor

Zygomycetes, Mucorales

Mycelium profusely developed. Sporangiophores erect, simple or branched, all branches terminated by sporangia which are globose to pyriform with a columella and thin wall; gametangia essentially alike, suspensors without definite outgrowths; hyaline chlamydospores sometimes formed.

Mucor mucedo. **Postharvest Rot** of tomato.
Mucor piriformis. **Postharvest Rot** of tomato. **Fruit Rot** of cherry.
Mucor racemosus. **Storage Rot** of sweetpotato, occasional after chilling; **Fruit Rot** of citrus. Control with low temperatures and dry atmosphere in the storage house.

Mycoleptodiscus

Mycoleptodiscus terrestris. **Root and Stem Rot** of soybean and birdsfoot trefoil.

Myrothecium

► Leaf Spots.

Myrothecium roridum. **Ring Rot** of tomato, **Crown Rot** of snapdragon and pansy. Crowns of greenhouse snapdragons appear water-soaked, then covered with a thin white mycelium and numerous black sporodochia. Irregular brown spots on tomato fruits are surrounded by slight depressions. Also causes root rot of red clover and alfalfa.
Myrothecium sp. On Bells of Ireland, causing crown necrosis. Stems are girdled at ground level; tops wilt; basal branches die.

Nematospora

Ascomycetes, Saccharomycetales

This is a yeast or budding fungus, following after insect injury; asci, with 8 to 16 spores, derived directly from vegetative mycelial cells; spores elongate, fusiform to needle-shaped, flagellate.

Nematospora coryli. **Yeast Spot** of soybean, **Dry Rot** of pomegranate, citrus, **Pod Spot** of pepper, bean and soybean, **Cloudy Spot** of tomato, **Kernel Spot** of pecan. The yeast is almost always associated with plant bug injury. The western leaf-footed plant bug carries the fungus from pomegranate to citrus. On pomegranates depressed light spots in flesh around seeds are followed by general browning and collapse. In citrus, the juice sacs just inside the rind dry out with a brownish to reddish stain. Cloudy spot on tomato fruit is associated with pumpkin bugs and leaf-footed plant bugs. Brown areas are formed on pecan kernels.
Nematospora phaseoli. **Yeast Spot** of lima bean, a seed disease, destructive from Maryland southward. Infection follows puncture of pods by the southern green stinkbug and possibly other insects. The seed lesions are dark brown, sunken, wrinkled.

Neurospora

Ascomycetes, Sordariales

Perithecia flask-shaped, membranous; ascospores dark, one-celled with gelatinous coating; conidial stage monilioid

Neurospora sitophila. **Ripe Rot** of pear. The fungus is the same one causing pink bakery mold on bread. There is a luxuriant pink growth over fruit; conidia are formed in chains.

Nigrospora

Deuteromycetes, Hyphomycetes

All hyphae more or less creeping, hyaline; conidiophores short, dark, cells somewhat inflated; conidia black, one-celled, situated on a flattened, hyaline vesicle at top of the conidiophore.

Nigrospora oryzae. **Ripe Fruit Rot** of tomato, **Nigrospora Cob Rot** of corn. Corn cobs are shredded, with the pith completely disintegrated; kernels are filled with masses of black spores. Corn on poor soil is more susceptible; stalks break over at any point. Rapid drying checks infection of seed corn.

Olpidium

Chytridiomycetes, Spizellomycetales

Endobiotic, living in host cells or tissues, living or dead.

Olpidium brassicae. Sometimes found in outer cells of rootlets of cabbage and other crucifers, tomato, lettuce and other plants, producing zoosporangia and resting spores in the cells. The effect on the host is usually merely a slight unthriftiness. Olpidium has been found associated with a disease of lettuce, Big Vein, now thought due to a virus.

Omphalia

Basidomycetes, Agaricales

Gills decurrent, cap sunken in center, somewhat funnel-shaped; central cartilaginous stem; spores white.
Marasmiellus pigmentatus (formerly *Omphalia pigmentata*). **Omphalia tralucida**. Decline Disease of date palms. Growth is retarded; roots decay; leaves die prematurely; fruit is worthless. Deglet Noor variety is most susceptible. Select thrifty offshoots from healthy plants for new date gardens. Soil can be treated with carbon disulfide, as for Armillaria rot.
Omphalia pigmentata (**Omphalia tralucida**) (see *Marasmiellus pigmentatus*). Decline Disease of date palms.

Oospora (Geotrichum)

Deuteromycetes, Hyphomycetes

Slender branched or unbranched mycelium breaking up into ellipsoidal or spherical hyaline or light-colored conidia called "oidia."

Geotrichum citriaurantii (formerly *Oospora citri-aurantii*). Sour Rot of citrus. This is a soft, putrid slimy rot of fruit, mostly of stored lemons, where it is spread by contact. The mycelium forms a thin, compact, somewhat wrinkled layer over the surface. Fruitflies help to spread the spores. Fruit should be stored as short a time as possible and frequent inspections made during storage.
Geotrichum candidum (formerly *Oospora lactis*). Sour Rot, Watery Fruit Rot of tomato, common in transit and market, especially on fruit from the South. There is a velvety or granular coating over the surface or a fluffy growth along the margin of cracks, and a disagreeable odor and flavor. The rot is common on ripe fruit touching the ground, occasional on green fruit. The fungus is a weak parasite, entering through wounds.
Oospora citri-aurantii (see *Geotrichum citriaurantii*). Sour Rot of citrus.
Oospora lacti (see *Geotrichum candidum*). Sour Rot, Watery Fruit Rot of tomato, common in transit and market, especially on fruit from the South.

Ophiosphaerella

Deuteromycetes, Hyphomycetes

Ophiosphaerella sp. Large Brown Patch Rot on bermudagrass and creeping bentgrass.

Paecilomyces

Deuteromycetes, Hyphomycetes

Conidiophores and branches more divergent than in *Penicilllium*; conidia (phialospores) in dry basipetal chains, one-celled, ovoid to fusoid, hyaline.

Paecilomyces buxi (see *Sesquicillium buxi*). **Root Rot** and **Decline** on boxwood.

Sesquicillium buxi (formerly *Paecilomyces buxi*). **Root Rot** and **Decline** on boxwood.

Pellicularia

► Blights.

Thanatephorus cucumeris (Syn. *Pellicularia filamentosa*) (considered by some *Botryobasidium*). **Rhizoctoniose**, **Black Scurf** of potatoes, stem canker and soil rot of beans (see under Blights for Web Blight of beans and other plants); Rhizoctonia Dry Rot Canker of Beets, Crown and Crater Rot of Carrots; Rhizoctonia Disease of Celery, Crucifers, Cucurbits; Bottom Rot of Lettuce; Damping-Off of Pepper and Eggplant; Root Rot of Onion; Root and Basal Stem Rot of Pea; Crown Rot of Rhubarb. The sterile state of this fungus, *Rhizoctonia solani*, was first named in 1858 in a German textbook and is still the most familiar term for a fungus with many pathogenic strains causing many types of diseases.

Any cook has seen signs of the pathogen on potato tubers – small brown to black hard flecks, sclerotia, on the skin. They look like particles of dirt but do not scrub off when potatoes are washed. There may be only one or two sclerotia, or they may nearly cover the whole surface of the tuber. When such potatoes are planted, the growing point may be killed. Some sprouts renew growth after being girdled, which may be repeated until they die. Larger plants have stems decayed just below the soil line, interrupting the downward transfer of food and resulting in a cluster of green or reddish aerial tubers. Roots may be killed back extensively. Most of the tubers are small, often with a brown jelly rot at the stem end.

Under moist conditions a white cobwebby weft of mycelium is formed at the base of potato stems, and the basidial stage is produced as a powdery crust on this weft. The fungus winters as mycelium or sclerotia in soil or tubers. The

mycelium can grow saprophytically long distances in the soil independent of any plant. Infection is favored by cool temperatures; the disease is most serious in wet seasons on heavy soils. The average yearly loss for the country is about 10 million bushels, 2 to 3%, but individual losses may be from 5 to 50%. For control use healthy tubers for seed.

Thanatephorus cucumeris (Syn. *Pellicularia filamentosa* (Anamorph, *Rhizoctonia solani*)). **Brown Patch** of turf, **Root and Leaf Rot** of lawn grasses, wheat grass, bentgrass, fescues, ryegrass, Kentucky bluegrass (infrequently on Canada bluegrass), St. Augustine grass, and Bermuda grass. Brown or blackish patches on the turf resemble sunscald or chinch bug injury. The areas are roughly circular, from an inch to 3 feet across, sometimes up to 20 feet. The fungus works outward with a "smoke ring" of grayish black mycelium at the advancing margin. The leaves are first water-soaked, black, then collapsed, dry and light brown, but the roots are seldom killed. The disease develops most rapidly during warm humid periods and with an excess of nitrogen.

Thanatephorus cucumeris (Syn. *Pellicularia filamentosa* (Anamorph, *Rhizoctonia solani*)). **Root and Stem Rot**, **Damping-Off** of ornamentals. In wet weather cobwebby mycelium develops on lower portions of stems; the lower leaves rot and upper portions of plants wilt and die. Seedlings and older plants so rotted include *Aconitum*, abelia, *Achillea, Ageratum*, aster, artichoke, begonia, calendula, campanula, carnation, endive, dahlia, delphinium, geranium, iris, lettuce, lupine, orchids, platycodon, poinsettia, salsify, sunflower and tulip. For control avoid excessive use of manure.

Penicillium

► Cankers.

Various species cause blue, green, occasionally pink molds, including the common blue-green mold on jellies. Some produce antibiotics, *Penicillium notatum* being the one used for production of penicillin.

Gliocladium roseum (formerly *Penicillium roseum*). **Fruit Rot** of citrus and of dates. A pink mold, found on lemons but not oranges.

Gliocladium vermoeseni (formerly ***Penicillium vermoeseni***). **Bud Rot** of palms. The terminal bud is killed and base of leaf stalks rotted. Affected trees of very susceptible *Washingtonia filifera* should be replaced with resistant *Washingtonia robusta*, Mexican fan palm. Also ► Cankers.

Penicillium aurantiogriseum. **Crown Rot** of asparagus, a seedling disease recently prevalent in Washington, following freezing injury. Bright blue spore masses appear on diseased crowns. Protect seedlings for winter by slight hilling in fall; avoid mechanical injury in harvesting; prevent drying out of crowns between digging and replanting.

Penicillium digitatum. **Green Mold** of citrus fruit, **Clove Rot** of garlic. On lemons and other citrus, olive-green powdery spore masses, forming a dust cloud when disturbed, cover fruit except for a band of white mycelium outside the green area. Garlic plants are yellow and stunted. Avoid injury in harvesting and packing. Commercial growers use chemicals in the wash water to prevent decay.

Penicillium expansum. **Blue Mold Rot** of many fruits; **Soft Rot** of apple, pear, avocado, pomegranate, Japanese persimmon, quince and feijoa. The decay on avocados is slow, and often the affected portions can be trimmed off. This fungus causes 80 to 90% of the decay of storage apples. The rotted portions are light-colored, soft, watery, with a disagreeable moldy taste and odor. A few rotted apples spoil all the others in a container. Use great care in harvesting and grading to avoid wounds; keep temperature as low as possible.

Penicillium gladioli. **Blue Mold Rot**, **Penicillium Dry Rot** of gladiolus, also found in imported bulbs – scilla, tritonia (montbretia). This is a storage rot. Light to dark brown sunken lesions appear on any part of corms with border of the decayed area water-soaked and greenish. Small grayish sclerotia are formed, and under moist conditions masses of blue mold. Dry rapidly after harvest, 80°F for 10 to 14 days, then store at low temperature; avoid wounds and bruises; sort before planting.

Penicillium italicum. **Blue Contact Mold** of citrus, **Fruit Rot**. The mold is blue in the older portion but powdery white at margins. It spreads readily from fruit to fruit by contact, through uninjured skin.

Penicillium roseum (see *Gliocladium roseum*). **Fruit Rot** of citrus and of dates. A pink mold, found on lemons but not oranges.

Penicillium vermoeseni (see *Gliocladium vermoeseni*). **Bud Rot** of palms.

Peniophora

Basidiomycetes, Aphyllophorales

Like *Corticium* but with cystidia.

Chaetoderma luna (formerly *Peniophora luna*). **Brown Rot** in lodgepole pine, Rocky Mountain area.
Peniophora luna (see *Chaetoderma luna*). **Brown Rot** in lodgepole pine, Rocky Mountain area.

Pestalotia

► Blights.

Pestalotia longisetula. **Root, Stolon, and Petiole Rot** on strawberry.

Phaeoacromonium

► Blights.

Phaeoacremonium aleophilum. **Decline** of grape.
Phaeoacremonium chlamydosporum. **Decline** of grape.
Phaeoacremonium inflatipes. **Decline** of grape.

Phialophora

Deuteromycetes, Hyphomycetes

Conidiophores dark, short, single or clustered; phialides broader near middle, tapering toward ends, producing conidia endogenously, spores subhyaline to dark, one-celled.

Phialophora malorum. **Storage Rot** of apples.

Phlebia

Basidiomycetes, Aphyllophorales

Basidiocarp effuse, typically monomitic; spores even in general outline, hyaline or pale in color, typically nonamyloid.

Phlebia chrysocrea. **Heart Rot** on oak.

Pholiota

Basidomycetes, Agaricales

Spores ochre yellow to rusty brown; gills attached to stipe, which has an annulus but no cup at the base.
Pholiota adiposa. **Brown Mottled Heart Rot** of maple and other living hardwoods – basswood, birches, poplars and more rarely conifers. The wood has brown mottled streaks. The sporophores are formed in clusters on trunks and stumps – m ushrooms with yellow central stems and caps, sticky yellow slightly scaly upper surface, yellow to brown gills.

Phoma

► Blackleg.

Phoma apiicola. **Phoma Root Rot** of celery, occasionally serious, especially in Golden Self Blanching, also on carrot, parsnip, parsley and caraway. The disease appears first in the seedbed, a black rot of the crown or base of leafstalks. Plants are stunted, outer leaves or entire plant killed, falling over as roots rot off. Spores are produced in tendrils from black pycnidia and spread in rains and irrigation water. Use clean seed, grown in California, where the disease is rare; sterilize seedbed soil or use a fresh location.
Phoma betae (Teleomorph, *Pleospora betae*). **Phoma Rot** of beets, causing black root of seedlings, necrotic streaks on seedstalks, brown spots on old leaves and rot of fleshy roots. The fungus is seed-borne and winters in roots carried over for seed production and in debris. Crop rotation is essential.
Phoma destructiva. **Phoma Rot** of tomato, pepper, nearly general, especially in the South, but not in North Central States. Small, irregular dark spots appear on leaves in great numbers; zonate markings are similar to those of early blight. Severely infected leaves turn yellow, wither. Fruit spots in field are small, 1/8 inch, slightly depressed, with numerous tiny black pycnidia. After harvest, spots enlarge to 1/2 to 1 1/2 inches and become black, leathery, with minute pustules. The fungus winters in decaying refuse in soil; seedbed infection is common, and the disease reaches the field via infected seedlings. Masses of spores produced on leaves are washed to fruits by rain or spread by workers and are distributed during harvesting and packing.

Control. Locate seedbeds away from land that has previously grown tomatoes; spray as for early blight; do not harvest when wet.
Phoma macdonaldii (Teleomorph, *Leptosphaeria lindquistii*). **Stem Rot** on sunflower.
Phoma terrestris on sweet corn.
Phoma sp. **Crown and Root Rot** on bugleweed.

Phomopsis

► Blights.

Phomopsis amygdali. **Fruit Rot** on almond.
Phomopsis mali. **Fruit and Core Rot** (Postharvest) on apple.
Phomopsis vaccinii. **Fruit Rot** on blueberry.
Phomopsis sp. **Fruit Rot** on peach.

Phymatotrichopsis (Phymatotrichum)

Deuteromycetes, Hypohomycetes

Conidiophores stout with inflated tips bearing loose heads of conidia; spores hyaline; one-celled, produced on surface of soil.

Phymatotrichopsis omnivors (formerly *Phymatotrichum omnivorum*). **Texas Root Rot**, **Phymatotrichum Root Rot**, **Cotton Root Rot**. This is the most destructive plant disease in Texas, a limiting factor in gardening and crop production. It occurs in the Red River counties of Oklahoma, the southwestern half of Arizona, the southeastern edge of Nevada and California, the southeastern corner of Arkansas and Utah, the northwestern corner of Louisiana and in most of Texas except the Panhandle.
The list of susceptible plants flowers, vegetables, fruits, field crops and trees – is much longer than that of plants resistant to this omnivorous fungus, so aptly named. At least 1700 plant species are attacked, more than by any other known pathogen. Because of the wide host range and destructiveness, the economic losses are enormous, $100 million a year in Texas alone, with perhaps $50 million in adjacent states.
Crops that either are resistant or escape the disease are the cereals and grasses, annuals grown in winter only, and sweet alyssum, amaranth, sweet basil,

beauty-berry, bee-balm, collinsia, diosma, calceolaria, calla lily, California-poppy, candytuft, canna, chicory, cranberry, cucumber, currant, cyclamen, daffodil, dahoon, deutzia, dill, fenner, fern, staghorn, foxglove, freesia, gold-entuft, mustang grape, gypsophila, hackberry, hoarhound, hyacinth, iris, lily, nigella, marsh-marigold, mignonette, mints, mimulus, muskmelon, mustard, nasturtium, oak, osage-orange, oxalis, Indian paint-brush, palms, pansy, petunia, phlox, Chinese pink, pitcher-plant, pomegranate, poppy, portulaca, primrose, pumpkin, red-cedar, sage, scarlet-brush, snapdragon, snowdrop, stock, strawberry, strawflower, tuberose, valerian, verbena, violet, wallflower, wandering jew, water cress, watermelon, yaupon, yucca and zinnia.

Phymatotrichum root rot occurs from July until frost. It kills plants in more or less circular spots, ranging from a few yards to an acre or more. Death may come within a few days of first wilt symptoms, and just preceding the wilt plants actually run a fever, with a higher than normal temperature. If plants next to the wilted ones are pulled out, these apparently healthy plants will often be found to be covered with yellow to buff mats of mycelium, and under moist conditions spore mats appear on the surface of the soil around diseased plants. Such mats are 2 to 12 inches in diameter, first snow white and cottony, later tan and powdery from spores produced in quantities. The fungus spreads through the soil by means of rhizomorphs, smooth, dark brown strands. The rate of spread may be 2 to 8 feet a month in an alfalfa field, 5 to 30 feet a season in a cotton field, or around fruit trees.

Sclerotia are formed along the mycelial strands. They are small, roundish, light at first, then dark and warty. The fungus winters either as sclerotia in soil, persisting several years in the absence of live hosts, or as dormant mycelium in living roots. The disease is most common and severe on heavy, alkaline soils. Abundant organic material reduces rot by favoring antagonistic soil saprophytes.

Control. In ornamental plantings replace diseased plants with some of those given in the resistant list. Monocotyledons are generally resistant. In locating new orchards, make sure that root rot has not been present previously by growing an indicator crop of cotton for a year. Grow immune crops in rotation with susceptible crops, and grow susceptible annuals in winter rather than summer. Try heavy manuring.

Ammonium sulfate can sometimes save a valuable ornamental tree or shrubs already infected with root rot. Prune back the top, make a circular ridge about the plant at the edge of the branch spread, and work ammonium sulfate into the soil within the ridge then fill the basin with water to a depth of 4 inch-

es. The chemical treatment and watering is repeated in 5 to 10 days, then no more chemical the same season. Follow through with frequent watering.

Phymatotrichum omnivorum (see *Phymatotrichopsis omnivors*). **Texas Root Rot**, **Phymatotrichum Root Rot**, **Cotton Root Rot**.

Physalospora

► Cankers.

Botryosphaeria stevensii (formerly *Physalospora mutila*). **Black Rot** of apple, in the West, similar to disease by *P. obtusa* in the East.

Botryosphaeria obtusa (formerly *Physalospora obtusa*). **Black Rot** of apple, **New York Apple Tree Canker**, **Frog-Eye Leaf Spot**, general on apple and crabapple, from Atlantic Coast to the Great Plains; also widespread on pear, mountain-ash, peach, quince, currant and various woody species. The fungus, in its anamorph state (*Sphaeropsis malorum*), was first reported as causing apple rot in 1879.

The lesions start as small brown spots, frequently at a wormhole, but they darken and turn black as they expand. There is usually one lesion to an apple, often at the calyx end, with concentric zones of black and brown, and minute black pycnidia. The rot eventually takes in the whole fruit, which is shriveled and wrinkled and finally mummifies. The pycnidia are black, carbonaceous, and may contrain three types of spores – large one-celled brown spores, large hyaline spores, and two-celled colored spores. Perithecia, sometimes formed in cankers or on twigs, apparently play little part in the life history, the fungus wintering as dormant mycelium or in the pycnidial state. Conidia, entering through wounds, start primary infection in spring on leaves with the small "frog-eye" leaf spots.

Control. Use the same spray schedule as for apple scab, starting with the petal-fall application. Clean up mummied apples; avoid bruising; cut out cankers.

Botryosphaeria rhodina (formerly *Physalospora rhodina*). **Diplodia Rot** of citrus, fig, rubber-tree and pear, possibly apple. The conidial stage is a *Diplodia*, probably *D. natalensis*, with dark, two-celled spores.

Physalospora mutila (see *Botryosphaeria stevensii*). **Black Rot** of apple, in the West, similar to disease by *P. obtusa* in the East.

Physalospora obtusa (see *Botryosphaeria obtusa*). **Black Rot** of apple, **New York Apple Tree Canker**, **Frog-Eye Leaf Spot**, general on apple and crabapple, from Atlantic Coast to the Great Plains; also widespread on pear, mountain-ash, peach, quince, currant and various woody species.
Physalospora rhodina (see *Botryosphaeria rhodina*). **Diplodia Rot** of citrus, fig, rubber-tree and pear, possibly apple.

Phytophthora

► Blights.

Phytophthora cactorum. **Stem Rot**, **Foot Rot** of lily, *Photinia*, tulip, *Hydrastis*, blue laceflower, baby's breath, *Centaurea*, peony, clarkia, rhubarb and tomato; leather rot of strawberries; collar rot of dogwood, walnut, apple and pear; crown rot of Euonymus and strawberry; root rot of boxwood and vinca, and crown rot of peach and Cannan fir; kernel and shuck rot of pecan. With foot rot, lilies suddenly fall over, wilt and die; the lower part of the stem is shrunken. Plant only healthy bulbs and where the disease has not occurred previously.
Strawberry leather rot occurs when berries come in contact with soil, starting with a brown rotted area on green fruit and a discoloration of vascular bundles. Ripe fruit has a bitter taste. Crown rot of rhubarb starts with slightly sunken lesions at base of petiole, which enlarge until the entire leaf collapses. Spraying crowns with bordeaux mixture is helpful. Start new beds with healthy plants. Collar rot on English walnut is a bark disease starting below the ground with irregular dark brown or black cankers and soft, spongy areas at the crown, a black fluid in cambial cavities. Trees are stunted, with sparse yellow-green top growth. There may be an unusually heavy crop of nuts, but the tree dies the next season. Grow walnuts grafted on Persian or Paradox rootstocks. See under Cankers for symptoms on apple and dogwood.
Stem rot and wilt of snapdragon starts with water-soaked lesions on the stem; these turn yellow, brown, enlarge to girdle the stem; plant wilts. Sterilize soil before planting.
Phytophthora capsici. One of the species causing buckeye rot of tomato. See under Blights for pepper rot and blight.
Phytophthora cinnamomi. **Avocado Root Rot**, **Pine Little Leaf**, **Collar Rot** of hardwoods and conifers, seedling root rot, on more than 100 hosts,

including firs, cedars, cypress, juniper, Japanese umbrella tree, larch, pine, spruce, arborvitae, heaths, heather, azalea, Heuchera, cranberry, highbrush blueberry, rhododendron, camellia, birch, western swordfern, manzanita, walnut, oak, locust, yew, venus-flytrap and gold-dust plant. In conifers root rot is dry with resin flow; needles gradually lose color. Infected tissue of hardwoods turns reddish brown except in black walnut, where it is black; seedlings die. The disease is aggravated in pine by poor aeration and low fertility.

Root rot is the most serious avocado disease in California, present also in Florida and Texas. It occurs on soils with poor drainage, excess moisture being necessary. As the roots rot, leaves become light-colored and wilt even if soil is moist; trees decline over a period of years. The fungus can be spread with seed if fruit is allowed to lie on the ground. Treat suspected seed with hot water, 120° to 125°F for 30 minutes; use nursery stock grown in fumigated soil; prevent movement of soil water from infested areas; plant on well-drained soil; water trees individually to avoid excess moisture.

Phytophthora citricola. **Root Rot** of pine, hemlock and Fraser fir seedlings in Christmas tree plantings; also fruit rot of avocado.

Phytophthora citrophthora. **Root and Crown Rot** of Penstemon.

Phytophthora citrophthora. **Brown Rot**, **Gummosis**, **Foot Rot** of citrus. Masses of amber gum break out from the trunk near crown; the bark is killed above and below ground; foliage turns yellow; trees may die. The disease is prevalent where excess water stands around the tree after irrigation or where there is poor drainage. Brown rot of fruit is a decay with no visible surface mold, except in moist air, but a slightly rancid, penetrating odor. Lemons and oranges may be affected on the tree, on branches near the ground, and there is much loss in storage. The fungus lives in the soil; spores are splashed up in rainy weather and are spread in the washing tank. Lemons are most susceptible to gummosis, then lime, pumelo, grapefruit, sweet orange and finally sour and trifoliate oranges. The latter two are used as fairly resistant understocks.

Control. Plant susceptible trees high, with lateral roots barely covered; expose the root crown of infected trees with a basin 6 inches deep and 4 feet across. Once a year cover crown and lower trunk with bordeaux paste. To control fruit rot, spray ground and lower branches, up to 3 feet, with bordeaux mixture just before rains begin. If fumigation is to be practiced, substitute a copper-zinc-lime spray for the bordeaux.

Phytophthora colocasiae. **Root Rot** of ginseng.

Phytophthora cryptogea. **Collar Rot** of rhododendron, China aster, marigold, gloxinia and zinnia; root, crown, and stem rot on watercress, juniper, African daisy, chicory, beet, globe thistle, lettuce, parsley, peach, sage, spruce, and ice plant; stem rot on sunflower, pink rot of potato. Stems and roots appear water-soaked, then black from a soft rot. Sterilize soil.

Phytophthora cryptogea var. **richardiae**. **Root Rot** of calla. The feeder roots rot from tips back to rhizomes, leaving the epidermis a hollow tuber. New roots sent out from the rhizome rot in turn. Leaves turn yellow and drop, starting with outer leaves; plants do not flower, or the tips of blossoms turn brown. Rot in the rhizome is dry and spongy, not wet and slimy. Clean old rhizomes thoroughly; cut out rotted spots. Grow in sterilized pots rather than benches.

Phytophthora drechsleri. **Root Rot** on fir, basil, blackberry, columbine, juniper, sage, linden, pine, and spruce. Sometimes associated with tomato buckeye rot, basal decay of sugar beets, tuber rot of potato, root rot of safflower.

Phytophthora erythroseptica. **Pink Watery Rot** of potato, **Rot** of calla lily and golden calla, **Crown and Root Rot** of wild rice. The rot starts at stem end of potatoes; affected tissues exude water under pressure. When tubers are cut, flesh turns pink or red, then black. The fungus can exist in soil 4 years.

Phytophthora fragariae. **Strawberry Red Stele Disease**, **Brown Core Rot**, a very serious strawberry disease, first noticed in Illinois in 1930, now widespread in northern strawberry sections and in California. A strain of this pathogen causes root rot of loganberry. The fungus attacks roots only, destroying fine feeding roots first, then invading the central cylinder, stele, which turns dark red. New spring leaves on badly affected plants are small, bluish, have short petioles; large leaves from the previous season dry up; little or no fruit is produced; plants die in the first dry period or are stunted.

The fungus is most active in cold, wet soil, in rainy periods in late fall, winter, and early spring except when ground is frozen. Zoospores produced on roots are spread by water; resting spores formed in the red stele carry the pathogen in a dormant state through the heat of summer. There are at least three physiological races, and once the fungus infests a field it is worthless for strawberries for 10 years.

Control. Buy clean, certified plants. Aberdeen and Stelemaster varieties are resistant; Temple, Sparkle, Fairland, Redcrop, and Pathfinder, fairly so.

Phytophthora lateralis. **Cypress Root Rot** on Lawson cypress (*Chamaecyparis lawsoniana*) often called Port Orford cedar, and Hinoki cypress (*C. obtusa*), killing thousands of trees in Oregon nurseries and landscape plantings. It is found on juniper and azalea in North Carolina. It is also reported on mountain-laurel and *Photinia* in NC and on cypress from Washington and apparently native to the Northwest. The fungus enters through the roots and spreads to lower part of main trunk killing the tissues. Blue cypress changes to purple, green, finally tan and dies. The color changes take several months in cool, damp weather, only 2 or 3 weeks in hot, dry weather. There is no practical chemical control, and Lawson cypress seems to be incompatible with resistant rootstocks. Grow disease-free propagating stock in new soil. Avoid large plantings of Lawson cypress such as windbreaks or hedges. Remove and destroy infected plants, getting the entire root system.

Phytophthora megasperma. **Root Rot**, occasional on cabbage, cauliflower, brussel sprouts, carrot, artichoke, stock, citrus, soybean and wallflower. Diseased plants wilt suddenly; leaves turn red to purple; underground stems and roots rot. The disease is more prevalent in winter plantings in California and in low, poorly drained areas. Level ground properly before planting to avoid waterlogged spots. Root and crown rot on peach.

Phytophthora megasperma f. sp. **glycinea**. **Root and Stem Rot** on soybean.

Phytophthora nicotianae var. **nicotianae**. **Crown Rot**, **Root Rot**, and **Stem Canker** on flannel bush.

Phytophthora nicotianae var. **parasitica** Syn. *Phytophthora parasitica* (*P. terrestris*). **Brown Rot** of citrus, in Florida; **Buckeye Rot** of tomato, also on lily roselle, sempervivum, potato (tuber rot), zebra plant (stem rot), sage (root rot), and Christmas cactus (root rot). The disease appears on the lowest tomato fruits, where water stands after rains. The lesions have concentric narrow dark brown bands alternating with wide light brown bands. The decay is rapid and the internal tissue semi-watery, though the exterior is firm. Control by staking tomatoes; avoid poorly drained soil or plant on ridges. This species is often present with *P. citrophthora* in cases of citrus foot or collar rot.

Phytophthora nicotianae var. **parasitica**. **Crown Rot** on petunia and poinsettia (stem rot).

Phytophthora palmivora. **Palm Bud Rot**, **Leaf Drop**, **Wilt** of coconut, *Washingtonia*, and queen palm, root and crown rot of mango; also root rot on English ivy. The fungus is an omnivorous tropical species, presumably the

one causing stem rot of dieffenbachia and peperomia. It has been prevented in nurseries by using cuttings from healthy plants in pasteurized soil.
Phytophthora parasitica var. **nicotianae** (Syn. *P. nicotianae* var. *parasitica*). **Root Rot** on pine.
Phytophthora porri. **Head Rot** on cabbage.
Phytophthora sojae (Syn. *P. megasperma* f. sp. *glycinea*). **Root and Stem Rot** of soybean, a relatively new disease reported from Illinois, Indiana, Missouri, North and South Carolina and Ohio. Serious in cool rainy weather, causing pre- and post-emergence damping-off.
Phytophthora syringae. **Root Rot** on shore juniper and Photinia.
Phytophthora torulosum. **Root Rot** and **Damping-off** on soybean.

Plectospira

Oomycetes, Saprolegniales

Sporangium with much inflated branching; swarm spores are formed in basal portion and cut out into a single row in an elongate filamentous apical portion, which acts as an exit tube. Swarm spores encyst at the mouth as in *Aphanomyces*. Oogonium terminal or intercalary, accompanied by up to 65 antheridia.

Plectospira myriandra. **Rootlet Necrosis** on tomato. The fungus is weakly parasitic on roots.

Plenodomus

Deuteromycetes, Coelomycetes

Pycnidia coriaceous or carbonaceous, more or less sclerotoid. Condiophores obsolete or none; conidia one-celled, hyaline.

Plenodomus destruens. **Foot Rot** of sweetpotato, one of the more important field diseases and sometimes a storage rot. The base of the stem turns brown from just under the soil surface to 4 or 5 inches above; leaves turn yellow and drop off; vines wilt unless adventitious roots are put out; pycnidia are numerous. The root has a firm brown rot, not affecting the whole potato but enough to make it worthless for food. The fungus winters in old plant refuse but not in soil. Use clean seed potatoes; rotate crops. This fungus also infects *Jacquemontia*.

Pleospora

► Leaf Spots.

Pleospora herbarum. **Fruit Rot** of tomato. A firm dark rot develops in fruit after picking, starting from infections through cracks near stem end of fruit. Progress is most rapid at 65° to 70°F and is checked by storage at 45°F.

Pleurotus

Basidiomycetes, Agaricales

Stipe off center or lacking; cap sometimes inverted; gills more or less fleshy and separable into two layers, edges acute; spores white.

Hypsizygus ulmarius (formerly *Pleurotus ulmarius*). **Brown Heart Rot** sapwood wound rot of elm, maple, and other living hardwoods. Rot starting in heartwood may extend into sapwood; infected wood separates along annual rings. Annual sporophores have a long excentric stalk, and white to yellow to brown smooth upper surface. They issue from crotches and pruning wounds.

Pleurotus ostreatus, oyster cap. **White Flaky Sapwood Rot** of maple and other hardwoods, sometimes on living trees. A light-colored decay is surrounded by a narrow brown zone. Fleshy annual conks are shelving, sessile, or with a short, stout excentric stalk. The upper surface is smooth, white or grayish, gills extending onto the stalk, an edible fungus. Infection is through open wounds. **Wood Rot** of grape.

Pleurotus ulmarius (see *Hypsizygus ulmarius*). **Brown Heart Rot** sapwood wound rot of elm, maple, and other living hardwoods.

Polyporus

Basidiomycetes, Aphyllophorales

Pileus tough, thick, with a stipe, or as a shelf; pores rounded, small, tubes crowded.

Dichomitus squalens (formerly *Polyporus anceps*). **Red Ray Rot** on western conifers, causing heart rot of living trees but beneficial as a cause of rapid decay of slash in forests. Fruiting bodies rarely develop on living trees.

Ganoderma lucidum (formerly *Polyporus lucidus*). **Root Rot** on redbud.

Inonotus dryadeus (formerly *Polyporus dryadeus*). **White Root Rot**, occasional in oaks and conifers in the West. Roots are killed; tree dies. Decayed wood is white to cream; bark is loosened and shredded.

Inonotus hispidus (formerly *Polyporus hispidus*). **White Spongy Heart Rot** of living trees of black ash, oak, maple and birch; does not decay dead trees. Heartwood in upper portion of trunk is reduced to soft spongy yellow or white mass. Shelf sporophores, up to 10 inches wide, have dark brown, coarse, velvety to hairy upper surface and golden brown undersurface, turning dark brown with age. They are formed at branch stubs, frost cracks, or trunk cankers.

Inonotus tomentosus (formerly *Polyporus tomentosus* var. *circinatus* Syn. *Inonotus circinatus*). **Root Rot** of sand pine.

Laetiporus sulphureus (formerly *Polyporus sulphureus* Syn. *Laetiporus sulphureus*), sulphur fungus. **Red Brown Heart Rot**, **Brown Cubical Rot** in heartwood of maple and other living hardwoods and conifers, widespread on oak, balsam, Douglas-fir and spruce. The annual, shelflike fruiting bodies are most conspicuous – soft, fleshy, moist when fresh, with bright orange-red upper surface and brilliant yellow underneath, formed in overlapping clusters. When old they are hard, brittle, dirty white (see Fig. 3.50). Infection is through dead branch stubs and wounds.

Phaeolus schweinitzii (formerly *Polyporus schweinitzii*) **Root Rot** on pine.

Phellinus gilvus (formerly *Polyporus gilvus*). **White Sapwood Rot**, prevalent on dead trees, occasional on living trees. Small, annual, yellow to red, brown leathery to corky sporophores, developed in profusion.

Pitoporus betulinus (formerly *Polyporus betulinus* Syn. *Piptoporus betulinus*). **Brown Cubical Rot** of dead or dying gray and paper birches. Conks have smooth grayish upper surface with incurved margin.

Polyporus abietinus Syn. Hirshioporus abietinus (see *Trichaptum abietinum*). **Pitted Sap Rot**, **Hollow Pocket**, **White Pocket Rot** on fir.

Polyporus anceps (see *Dichomitus squalens*). **Red Ray Rot** on western conifers.

Polyporus balsameus (see *Postia balsamea*). **Balsam Butt Rot** of living balsam fir, eastern hem lock, northern white-cedar, western red-cedar, also prevalent on dead trees.

Polyporus betulinus Syn. **Piptoporus betulinus** (see *Piptoporus betulinus*). **Brown Cubical Rot** of dead or dying gray and paper birches.

Polyporus dryadeus (see *Inonotus dryadeus*). **White Root Rot**, occasional in oaks and conifers in the West.

Figure 3.50 Shelf Fungus (*Laetiporus sulphureus*) on Oak

Polyporus gilvus (see *Phellinus gilvus*). **White Sapwood Rot**, prevalent on dead trees, occasional on living trees.
Polyporus hispidus (see *Inonotus hispidus*). **White Spongy Heart Rot** of living trees of black ash, oak, maple and birch; does not decay dead trees.
Polyporus lucidus (see *Ganoderma lucidum*). **Root Rot** on redbud.
Polyporus pargamenus. **White Pocket Rot** of dead sapwood in eastern United States but sometimes on living maple and other hardwoods.
Polyporus sulphureus Syn. **Laetiporus sulphureus** (see *Laetiporus sulphureus*), sulphur fungus. **Red Brown Heart Rot**, **Brown Cubical Rot** in

heartwood of maple and other living hardwoods and conifers, widespread on oak, balsam, Douglas-fir and spruce.

Polyporus schweinitzii (see *Phaeolus schweinitzii*). **Root Rot** on pine.

Polyporus squamosus. **White Mottled Heart Rot** on maple, buckeye, birch and occasional on living trees near wounds. Conks are annual, fleshy, white to dingy yellow with a short, thick lateral stalk, upper surface with broad appressed scales, up to 18 inches wide.

Polyporus tomentosus var. **circinatus** Syn. **Inonotus circinatus** (see *Inonotus tomentosus*). **Root Rot** of sand pine.

Polyporus versicolor Syn. Coriolus versicolor (see *Trametes versicolor*), rainbow conk. **Sapwood Rot**.

Postia balsamea (formerly *Polyporus balsameus*). **Balsam Butt Rot** of living balsam fir, eastern hemlock, northern white-cedar, western red-cedar, also prevalent on dead trees. Advanced decay is brown, brittle, breaking into large cubes, easily crushed to a clay-colored powder. In living trees the rot column is usually only 3 or 4 feet from ground. Sporophores are shelving, up to 2 inches wide, with pale brown upper surface with concentric zones, white underneath.

Trametes versicolor (formerly *Polyporus versicolor* Syn. *Coriolus versicolor*), rainbow conk. **Sapwood Rot**. This is the most common fungus on hardwood slash in woods and sometimes on conifers. The rot is soft, white spongy. Heartwood of living catalpa may be decayed, the fungus entering through wounds and dead branches. The conks are thin, tough, leathery, annual, up to 2 inches wide with a hairy or velvety surface multicolored white, yellow, brown, gray, and black. The undersurface is yellow or white. This pathogen also causes wood decay and decline of apple and has been reported as *Trametes versicolor*.

Trichaptum abietinum (formerly *Polyporus abietinus* Syn. *Hirshioporus abietinus*). **Pitted Sap Rot**, **Hollow Pocket**, **White Pocket Rot** on fir. May attack dead sapwood in wounds of living trees.

Poria

Basidiomycetes, Aphyllophorales

Pileus resupinate, thin, membranous; tubes wartlike, separate.

Junghuhnia luteoalba (formerly *Poria luteoalba*). **Brown Rot** of coniferous wood.

Perenniporia subacida (formerly *Poria prunicola*). **White Rot** of cherry and other *Prunus* spp.
Phellinus laevigatus (formerly *Poria laevigata*). **Red Mottle Rot** on *Prunus* spp.
Phellinus weirii (formerly *Poria weirii*). **Douglas-Fir Root Rot**. The disease is most destructive to trees 70 to 150 years old, which are killed in groups. The fungus can persist in dead roots for a century. Less susceptible conifers should be planted with judicious cutting of infected stands.
Poria cocos (see *Wolfiporia cocos*). **Root Rot** on roots of various trees, especially pine, in southeastern United States.
Poria luteoalba (see *Junghuhnia luteoalba*). **Brown Rot** of coniferous wood.
Poria prunicola (see *Perenniporia subacida*). **White Rot** of cherry and other *Prunus* spp.
Poria laevigata (see *Phellinus laevigatus*). **Red Mottle Rot**, on *Prunus* spp.
Poria subacida. **Feather Rot**, **Spongy Root Rot**, **String Butt Rot** of living conifers and dead hardwood. Decay rarely extends more than 6 to 10 feet in the trunk. Irregular pockets run together forming masses of white fibers; annual rings separate readily. Sporophores are white to straw-colored to cinnamon-buff crusts forming sheets several feet long on underside of fallen trunks or on underside of root crotches or exposed roots of living trees.
Poria weirii (see *Phellinus weirii*). **Douglas-Fir Root Rot**.
Wolfiporia cocos (formerly *Poria cocos*). **Root Rot** on roots of various trees, especially pine, in southeastern United States. Huge sclerotia, weighing up to 2 pounds, are formed; this stage is known as *Pachyma cocos*.

Pyrenochaeta

► Blights.

Phoma terrestris (formerly *Pyrenochaeta terrestris*). **Pink Root** of onions, widespread on onions, garlic and shallot; also on grasses. Roots of affected plants shrivel and turn pink. New roots replacing the old are infected in turn; plants are stunted, bulbs small. The fungus persists indefinitely in the soil and is distributed on onion sets and transplants. Yellow Bermuda is the most resistant of commercial onion varieties. The green Beltsville Bunching onion, Nebuka strain of Welsh onion, Evergreen variety of shallot, and leaks

and chives are resistant. In Arizona, Granex gives a better yield than other onions despite pink root.
Pyrenochaeta lycopersici. **Root Rot** on tomato.
Pyrenochaeta terrestris (see *Phoma terrestris*). **Pink Root** of onions, widespread on onions, garlic and shallot; also on grasses.

Pythium

Oomycetes, Peronosporales

Wall of sporangium smooth; discharging swarm spores in imperfectly formed state into thin-walled vesicle, which later ruptures to allow spores to escape. Sporangia terminal or intercalary. Species live in moist soil causing damping-off and root rots.

Pythium acanthicum; **P. myriotylum**; **P. periplocum**. Causing rot of watermelon fruit.
Pythium aphanidermatum. **Leak**, **Root Rot**. Damping-off of muskmelon, cucumber, squash, also papaya, bean, radish, spinach, sugar beet, guayule, caper spurge, and ice plant. There is a watery decay with a yellow brown liquid leaking out when fruit is pressed. Lesions are brown and wrinkled. The fungus lives in the soil; primary infection is in the field, secondary from contact in transit or storage. Sort carefully before packing. Refrigerate at 45° to 50°F in transit.
Pythium aristosporum. **Root Rot** of bean.
Pythium arrhenomanes. **Root Rot** on tomato, broadleaf signalgrass, large crabgrass, barnyardgrass, nutsedge, goosegrass, itchgrass and johnsongrass.
Pythium carolinianum. **Root and Stem Rot** of parrotfeather (*Myriophyllum*).
Pythium catenulatum. **Root Rot** of bean.
Pythium debaryanum. **Damping-Off** of seedlings. **Watery Leak** of potatoes. Leak starts as a brown discoloration around a wound and soon spreads to include the whole potato, which is soft, easily crushed, and drips a brown liquid with the slightest pressure. Entrance to the tuber is usually through harvest wounds. *Pythium* hyphae grow through the soil in great profusion and can enter seedlings through either stomata or unbroken epidermis. See Damping-Off, for rot of seedlings.
Pythium dissotocum. **Root Rot** of bean, and spinach.
Pythium irregulare. Associated with **Melon Root Rot** and **Fruit Rots** of

Figure 3.51 *Pythium* Blackleg on Geranium

other cucurbits in cool weather and **Seed Decay** of corn. **Root Rot** and **Crown Rots** of clovers and basil.
Pythium mastophorum. **Damping-off** on celery.
Pythium myriotylum. **Root Rot** on tomato.
Pythium paroecandrum. **Stem, Crown and Root Rot** on lupine.
Pythium polymastum. **Bottom Rot** and **Damping-off** on cabbage.
Pythium splendens. On Chinese evergreen, peperomia, and philodendron.
Pythium ultimum. **Fruit Rot** of muskmelon, often with luxuriant white fungus growth; **Damping-Off**, **Root Rot** of many seedlings in greenhouse and

field. **Root Rot** and **Crown Rot** of clovers. **Crown Rot** of impatiens. **Root Rot** of kiwi.

Pythium uncinulatum. **Stunt and Leaf Yellowing** on lettuce.

Pythium spp. Most soils contain several species of *Pythium* ready to perform at optimum moisture and temperature. Exact determination is not always practical. Nematode wounds often dispose plants to rot. Diseases include African-violet rot, aloe root rot, black rot of orchids, begonia root rot, coleus black leg, geranium cutting rot (see Fig. 3.51), bean and parsley root rot, rhubarb crown rot, mottle necrosis of sweetpotato, and other rots. Some plants can be treated with hot water, 115°F for 30 minutes. Sterilize soil before use; avoid excessive watering. See Damping-Off, for seedling rots.

Rhizina

Ascomycetes, Pezizales

Cup-shaped apothecia with rhizoids underneath; asci operculate, opening with a lid, eight-spored; spores fusoid, spindle-shaped, paraphyses present.

Rhizina undulata. **Seedling Root Rot, Damping-Off**. Coniferous seedlings in the Pacific Northwest are sometimes killed in isolated circular patches 2 to 4 feet in diameter, particularly in burned areas. Infected roots are matted together with white mycelium. More or less resinous annual fructifications are formed on the ground. They are irregular, an undulating brown upper surface with narrow white margin, 2 to 3 inches across. There is no control, but the disease is minor.

Rhizoctonia

Deuteromycetes, Hyphomycetes

Sclerotial form of *Pellicularia, Corticium, Macrophomina, and Helicobasidium*. Young mycelium colorless; branches constricted at points of origin from main axis; older mycelium colored, wefts of brownish yellow to brown strands, organized into dense groups of hyphae, sclerotia, made up of short, irregular, angular or somewhat barrel-shaped cells (see Fig. 3.52).

Rhizoctonia sp. **Postharvest Decay** on leatherleaf fern.

Rhizoctonia bataticola. **Charcoal Rot**. ► *Macrophomina phaseoli*

Rhizoctonia crocorum. **Violet Root Rot**. ► *Helicobasidium purpureum*.

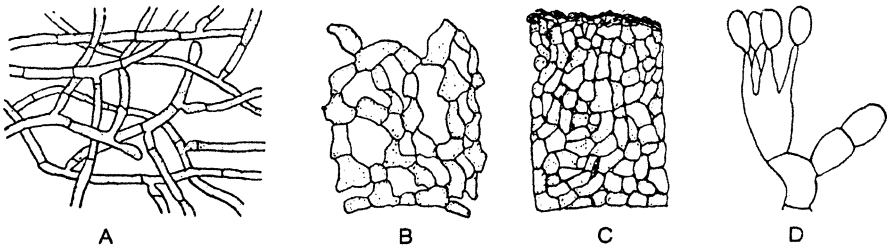

Figure 3.52 Forms of *Rhizoctonia solani*. **A** young mycelium, constricted at branches; **B** loosely formed angular to barrel-shaped colored cells; **C** section through sclerotium formed from aggregation of cells in **B**; **D** basidium and spores of *Pellicularia*, teleomorph state of *R. solani*

Rhizoctonia solani. **Black Scurf** of potatoes, **Brown Patch** of turf. ▶ *Pellicularia filamentosa* **Root Rot** and **Crown Rot** of clovers..

Rhizoctonia solani. **Root and Stem Rot** of poinsettia and other ornamental plants, including basil, begonia, camellia, calla, carnation, chrysanthemum, coleus, cornflower, geranium, gloxinia, impatiens, lily, pansy, pothos, peperomia, primrose, ragweed, rosemary, caper spurge, and sainfoin (crown rot). Although *Pythium* flourishes best in the low oxygen content of poorly drained soils, *Rhizoctonia*, causing similar root rots, is serious in well-drained soils. On poinsettia, dark brown lesions at or above soil level are often covered with brown mycelium; the leaves turn yellow and drop, the roots rot, and the plant dies. **Web Blight** and **Stem Canker** on alfalfa. **Damping-off** and **Bottom Rot** on Cichorum (endive, escarole and witloof chicory) and Nicotiana.

Rhizoctonia tuliparum. **Gray Bulb Rot** of tulips, in northeastern and Pacific states. The most conspicuous sign of this disease is a bare patch in spring where tulip shoots should be showing. Occasionally an infected bulb will produce some above-ground growth, but the plants are slow and often wither and die before flowering. Bulbs rot from the top down; mycelium forms felty masses between scales; on bulbs and in surrounding soil are masses of brown to black, flattened sclerotia, composed of the yellow-brown, thin-walled irregular cells typical of *Rhizoctonia*. These can survive in soil for years, germinating to infect bulbs after planting or in very early spring. Occasionally sclerotia are transported on bulbs, but the bulbs are usually so noticeably diseased that they are not sold.

Control. Remove soil and plants from affected area and for at least 6 inches beyond. Destroy all infected bulbs at harvest. Use a 4- to 5-year rotation.

Rhizopus

Zygomyetes, Mucorales

Sporangium large, globose, multispored, with a columella and a thin wall; sporangiola and conidia lacking. Sporangiophores arise in fascicles from aerial arching stolons, which develop rhizoids at point of contact with substratum (Fig. 2.2).

Rhizopus arrhizus. **Soft Rot** on gladiolus corms, light brown and on beet.
Rhizopus arrhizus (formerly *Rhizopus oryzae*). **Head Rot** on sunflower.
Rhizopus nigricans (Syn. *R. stolonifer*), the common black bread mold. **Soft Rot** of sweetpotato and other vegetables; **Rhizopus Rot**, **"Whiskers," Leak** of peach, strawberry, and other fruits. This is one of the more serious storage rots of sweetpotato, soft, watery, progressing rapidly, with rotting complete inside 5 days after visible infection. The tuber is brownish within, covered with a coarse whiskery mycelial growth; there is a mild odor. Cucurbits, crucifers, carrots, beans, lima beans, onions, peanuts, potatoes, Jerusalem artichoke, and guava are susceptible to this black mold. Nancy Hall and Southern Queen are among the more resistant varieties of sweetpotato. To prevent rot, cure at 80° to 85°F for 10 to 14 days, at high humidity, to permit rapid corking over of wounds; then store at 55°F.
The fungus is a weak parasite on ripe fruit – peach, fig, strawberry, citrus, persimmon, pear, avocado and melons. A coarse cottony mold appearing in wounds and over the surface is covered with sporangia, white when young, black at maturity. A watery fluid with an offensive odor leaks from the soft fruit. Avoid wounding in harvesting; do not pack overripe fruit; keep at low temperature in transit and market. Amaryllis, lily, and tulip bulbs may be infected.
Rhizopus oryzae (see *Rhizopus arrhizus*). **Head Rot** on sunflower.
Rhizopus stolonifer. **Soft Rot** of *Euphorbia trigona*.

Roesleria

Ascomycetes, Helotiales

Mycelium inconspicuous; apothecia cup-shaped, opening more or less completely; asci disappearing early, leaving a persistent mass of spores and paraphyses. Spores hyaline, one-celled, globose.

Roesleria hypogaea. **Root-Rot** of grape.

Rosellinia

Ascomycetes, Xylariales

Perithecia smooth, ostiole simple or with a low papilla; with a subicle under the fruiting layer; paraphyses present; spores olive to brown, one-celled.

Rosellinia necatrix (Syn. *Dematophora*). **White Root Rot** of fig, grape, avocado, apricot, cherry, apple, pear, peach, walnut, holly osmanthus, privet and poplar. This is like Armillaria root rot in that all trees in a certain area are killed, but there are no rhizomorphs or toadstools formed. A white mycelial growth on surface of affected roots turns black and cobwebby. During wet weather a delicate mold forms on surface of bark and on soil around base of tree. Foliage is sparse and wilting, growth slow or none. Crabapples are quite resistant. Plums and apricots can be grown on resistant understock.

Schizophyllum

Basidiomycetes, Aphyllophorales

Pileus leathery; stipe lateral or none; edge of gills split; spores white.

Schizophyllum commune. **Wound Rot**, common on dead parts of living trees– maple, boxelder, almond, acacia, ailanthus, birch, catalpa, hickory, peach, pecan and citrus, fig. Fruiting bodies are small, thin, sometimes lobed, up to 2 inches wide, fan-shaped with gray-white downy upper surface, brownish forked gills on underside, common on fruit trees. This pathogen also causes wood decay and decline of apple.

Sclerotinia

► Blights.

Botryotinia narcissicola (formerly *Sclerotinia narcissicola*). **Narcissus Smoulder**. Perhaps the fungus should be transferred to *Botryotinia*, since there is a conidial stage. The disease is a decay of stored narcissus bulbs, also known on snowdrop, and a rot of foliage and flowers in the open, especially during cold wet seasons. Leaves are distorted, stuck together as they

emerge from soil. Sclerotia are small, black, flattened bodies, up to 1/2 inch long when several grow together, just below outer papery bulb scales. In prolonged storage there is a yellow-brown rot.

Control. Remove and destroy diseased plants as soon as noticed; destroy weeds to provide air circulation; spray with bordeaux mixture; discard rotting bulbs at harvest; change location every year.

Sclerotinia homoeocarpa. **Dollar Spot**. **Small Brown Patch** of turf on bent grasses, fescues and bluegrass. Spots are brown at first, then bleached and straw-colored, about 2 inches in diameter but coalescing to large irregular patches. While leaves are being killed, a fine white cobwebby growth of mycelium can be seen in early morning when dew is present.

Sclerotinia intermedia. **Stem Rot**, market disease of celery, carrot and salsify.

Sclerotinia minor. **Stem Rot** of lettuce, celery, carrot, cocklebur, Austrian winter pea, lana woolly pod vetch, phacelia and basil; also stem rot on fennel, root and crown rot on cabbage, crown rot and wilt on *Cichorium* (*radicchio*). **Root and Pod Rot** of peanut. Resembles rot due to *S. sclerotiorum*, but sclerotia are much smaller. **Crown Rot** of pepper.

Sclerotinia narcissicola (see *Botryotinia narcissicola*). **Narcissus Smoulder**. Perhaps the fungus should be transferred to *Botryotinia*, since there is a conidial stage.

Sclerotinia sclerotiorum. **Black Rot** of bulbous iris, hyacinth, narcissus and tulip. Iris fails to start growth, or plants turn yellow, wilt, and die, often in clumps. Bulbs are covered with thin gray masses of mold with black irregular sclerotia between scales. Tulip leaves develop reddish color early in spring, wilt and die; stems and bulbs are rotted into a crumbly mass of fragments and black sclerotia. This is a cool-temperature fungus that stops action about the time the heat-loving *Sclerotium rolfsii* starts in. Remove diseased plants and surrounding soil as soon as noticed. Discard all small bulbs at harvest; plant healthy bulbs in clean soil. The pathogen supposedly dies out after 2 years in soil without suitable host.

Sclerotinia sclerotiorum. **Calyx-End Rot** on apple and **Root and Pod Rot** of peanut, **Root and Stem Rot** of alfalfa.

Sclerotinia sclerotiorum. **Green Fruit Rot** of almond, peach, apricot, fig and strawberry; **Rhizome Rot** of ginseng. In almond, young shoots and fruits are killed and wither soon after petals fall. Infection takes place through jackets from apothecia produced under trees where weeds or crop plants have been previously infected with cottony rot. Losses are serious only when there

is continuous wet weather during and after blooming. Spraying for brown rot helps to control green rot. Shaking or jarring trees after bloom to remove jackets from young fruits is suggested.

Sclerotinia sclerotiorum. **Leaf and Crown Necrosis** of African daisy; **Root Rot** and **Wilt** of peanut. **White Mold Rot** of soybean.

Sclerotinia sclerotiorum (*S. libertiana*). **Lettuce Drop**, **Watery Soft Rot** of endive; **Pink Rot** of celery, **Cottony Rot** of bean, carrot, parsnip, cabbage, and other crucifers and cucurbits. In lettuce, older leaves wilt and fall flat on the ground, leaving center leaves erect, but these are soon invaded by mycelium and reduced to a slimy wet mass. In continued moisture a thick, white cottony mold is formed, bearing large black sclerotia up to the size of peas (see Fig. 3.53). They winter in the soil, send up groups of apothecia in spring. These are brown, cup- to saucer-shaped, up to an inch across, on a stalk. Ascospores are ejected in a veritable cloud; there is no known conidial stage.

Control. In commercial celery fields deep plowing or flooding is used to inhibit apothecial production. Sterilize seedbed soil before planting.

Sclerotinia sclerotiorum. **Stem Rot** of pepper, cocklebur, tomato, and many ornamentals – aconite, basil, calendula, chervil, canola, chrysanthemum, cynoglossum, dahlia, daisy, delphinium, Gaillardia, gazania, hollyhock, peony, purple coneflower, snapdragon, sunflower, zinnia, and others. The same sort of cottony mold is formed on flower stems as on vegetables, but here the sclerotia are usually inside the pith and so are rather

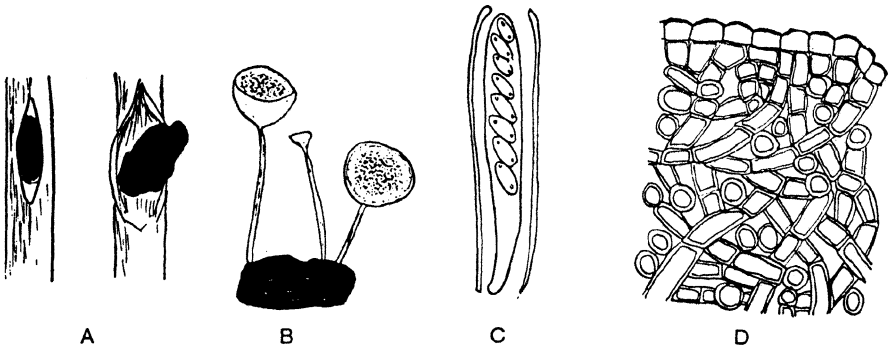

Figure 3.53 *Sclerotinia sclerotiorum*. **A** sclerotium formed in pith of stem and one falling out from broken stem; **B** apothecia produced from sclerotium on ground; **C** ascus with paraphyses; **D**, section through sclerotiorum, with colorless medulla and dark wall on rind cells

long and thin. You can feel them by running thumb and finger along the stem; sometimes the cottony mycelium, or cracks in the stem, or one or two external sclerotia indicate their presence. They are common in peony stems. When sclerotia are formed in flowers, the shape corresponds to floral parts. Sunflowers have large compound sclerotia.
Control. Cut out and destroy affected parts, trying to keep sclerotia from falling out onto soil. Dusting with sulfur sometimes checks rapid spread of mycelium.
Sclerotinia trifoliorum. **Root Rot**, **Stem Rot** of cocklebur and alfalfa.

Sclerotium

► Blights.

Sclerotium cepivorum. **White Rot** of onion, shallot and garlic. Affected plants die from a rotting at the neck, at which point there is a surface crust of small black sclerotia and a thin weft of white mycelium. The sclerotia are smaller and rounder than those of *Botrytis*. Roots are often rotted off, and sometimes spots in a field covering several square yards are infested.
Sclerotium rolfsii (including *Sclerotium delphinii*). **Crown Rot** of delphinium, iris, ajuga, aconite, quinoa, sainfoin, kiwi, and many other ornamentals and vegetables, **Root Rot** and **Wilt** of peanut, **Wet Scale Rot** of narcissus, **Southern Blight**. For a full discussion see *Pellicularia rolfsii* under Blights.

Seaverinia

Ascomycetes, Helotiales

Apothecia shallow, cup- to disc-shaped; a stroma formed but no definite sclerotia; conidia botryose.

Seaverinia geranii (Syn. *Sclerotinia geranii*). **Rhizome Rot** on geranium.

Steccherinum

Basidiomycetes, Aphyllophorales

This genus has been separated off from *Hydnum*. The pileus is sessile or substipitate and laterally attached, on a woody substratum; spines are terete or flattened; cystidia present; spores white, smooth.

Climacoden septentrionalis (formerly *Steccherinum septentrionale* Syn. *Hydnum septentrionale*) **White Spongy Rot** of heartwood of living maples, beech, hickory, and other hardwoods. A zone of brown discolored wood is around the white rot area, and there are fine black zone lines. The fruiting bodies are large, soft, soggy, creamy white, in very large, bracket-shaped clusters on trunks.

Hericium obietis (formerly *Steccherinum abietis* Syn. *Hydnum abietis*). **Brown Pocket Rot** of heartwood of living firs and western hemlock in Pacific Northwest. Elongated pockets, empty or with white fibers, are separated by firm reddish brown wood. Sporophores are like coral, white to cream, up to 10 or 12 inches high and wide, usually on dead trees, sometimes in wounds of living trees.

Steccherinum abietis Syn. ***Hydnum abietis*** (see *Hericium obietis*). **Brown Pocket Rot** of heartwood of living firs and western hemlock in Pacific Northwest.

Steccherinum septentrionale Syn. **Hydnum septentrionale** (see *Climacoden septentrionalis*) **White Spongy Rot** of heartwood of living maples, beech, hickory, and other hardwoods.

Stereum

Basidiomycetes, Aphyllophorales

Effused-reflexed to stipitate; spore-bearing surface smooth, pale brown, upper surface with a velvety coating of hairs, formed in several distinct layers; gloeocystidia and cystidia present or lacking; spores smooth, colorless.

Chondrostereum purpureum (formerly *Stereum purpureum*). **Silver Leaf, Sapwood Rot**, common on plums and other fruit trees, sometimes important on apples, occasional on shade and ornamental trees, widespread but more serious in the Northwest. The fungus enters through wounds; grows first in heartwood, and then kills sapwood and bark; infected branches develop foliage with dull leaden or metallic luster. If the disease is not checked, the entire tree may be lost. The sporophores appear after death, resupinate to somewhat shelf-shaped, with purple undersurface.

Stereum fasciatum (Syn. *S. ostrea*). **Brown Crumbly Rot**, mostly on slash, sometimes on maple and birch. Thin, leathery grayish sporophores with undersurface light brown, smooth.

Stereum hirsutum. **Wood Rot**, **Sapwood Wound Rot**, occasionally near wounds of living trees – birch, maple, hickory, mountain-mahogany, eucalyptus, peach, and others. Thin, leathery crustlike sporophores have hairy, buff to gray upper surface, smooth gray undersurface.

Control. Remove branches and burn at first sign of silvering. Protect trees from wounds; paint pruned surface with bordeaux paste or other disinfectant; keep brush removed from orchard.

Stereum purpureum (see *Chondrostereum purpureum*). **Silver Leaf**, **Sapwood Rot**, common on plums and other fruit trees, sometimes important on apples, occasional on shade and ornamental trees, widespread but more serious in the Northwest.

Stereum sanguinolentum. **Red Heart Rot** of slash and living conifers – firs and eastern white pine. Fruiting bodies are small, not over 2 inches wide; upper surface is a silky pale olive buff; lower surface "bleeds" readily when wounded, dries to grayish brown. Sporophores are produced in profusion on dead wood, occasionally on dead branches of living trees.

Streptomyces

Schizomycetes, Actinomycetales

Intermediate form between bacteria and fungi. Much-branched mycelium that does not fragment in bacillary or coccoid forms; conidia in chains on sporophores; primarily soil forms, some parasitic.

Streptomyces ipomoea (Syn. *Actinomyces ipomoea*) **Soil Rot or Pox** of sweetpotatoes, general New Jersey to Florida and in the Southwest. This pathogen also infects *Jacquemontia*. Leaves are small, pale green to yellow; plants are dwarfed, make little or no vine growth, and may die before end of the season; the root system is poorly developed with most roots rotted off, or breaking off if plant is pulled from the soil. Small dark lesions are formed on stems below the soil line. Pits with jagged or roughened margins, often coalescing, are formed on mature roots. The rot is found in soils at pH 5.2 or above; and is worse in dry soils and seasons. Variety Porto Rico is very susceptible.

Control. Apply sulfur to acidify soil to pH 5.0.

Stromatinia

Ascomycetes, Helotiales, Sclerotiniaceae

Apothecia arising from a thin, black, subcuticular, effuse sclerotium or stroma; small black sclerotia are borne free on mycelium, not giving rise to apothecia. There is no conidial stage; apothecia resemble those of *Sclerotinia*.

Stromatinia gladioli (Syn. *Sclerotinia gladioli*). **Dry Rot** of gladiolus, also found on crocus, freesia and tritonia. Lesions on corms start as reddish specks, with slightly elevated darker border; spots enlarge, and centers become sunken, dark brown to black with lighter raised edges; they grow together into irregular areas. On husks the lesions are tobacco brown. Very small black sclerotia are formed on husks, in corm lesions, and on dead stems. Plants in the field turn yellow and die prematurely owing to decay of leaf sheath. Corms may appear normal when dug, the rot developing in storage. The disease is more prevalent in heavy soils, and the fungus can survive several years in soil. Apothecia have been produced artificially by fertilizing receptive bodies on sclerotia with spermatia (microconidia). They are densely crowded, 3 to 7 mm broad, on stipes 6 to l0 mm high.
Control. Use soil with good drainage and a 4-year rotation. Removing husks before planting helps to reduce gladiolus rot diseases. Cure corms rapidly after harvest.
Stromatinia narcissi. Large-scale speck fungus on narcissus and zephyranthes. Black, thin, round, flat sclerotia 1/2 to 1 mm, adhere firmly to outer scales. The fungus is mostly on bicolor varieties and seems to be saprophytic without causing a definite disease.

Thielaviopsis

Deuteromycetes, Hyphomycetes

Hyphae dark; two kinds of conidia-small, cylindrical, hyaline endogenous spores and large, ovate, dark brown exogenous spores, both formed in chains.

Thielaviopsis basicola. **Black Root Rot**, seedling root rot of tobacco and many vegetables – bean, carrot, corn, chickpea, lentil, okra, onion, pea, tomato, corn-salad, vinca, and watermelon; and ornamentals – begonia, cyclamen, gerbera, elm, oxalis, lupine, pelargonium, peony, poinsettia, pansy, scindapsus, and others. There is blackening and decay of roots; young plants damp-

off and die; older plants are stunted, with the decay proceeding until all roots are destroyed. Stem discoloration extends 2 to 3 inches above the soil line. The fungus lives in soil as a saprophyte, entering through nematode wounds. Hyaline conidia produced inside conidioles are forced out through hyphal tips. Chlamydospores are larger, dark, club-shaped, with several cells; they break up so that each pillbox acts as a spore. This disease is especially serious on poinsettia, dwarfing plants, causing misshapen leaves and flower bracts.
The rot is most destructive in heavy, cold, slightly acid to alkaline soils well supplied with humus. Long wet periods after transplanting increase rot. Soils with pH lower than 5.6 or sandy soils low in organic matter are less conducive to disease.
Control. Sterilize soil for seedbeds; use clean pots for poinsettias and other greenhouse plants; reduce pH with sulfur or by using half peat moss and half soil.

Trametes

Basidiomycetes, Aphyllophorales

Pileus without stipe, sessile to effuse-reflexed, firm; hymenium white or pallid, punky to corky, not friable when dry; tubes unequally sunken.

Trametes suaveolens. **White Wood Rot** of willow and poplar, after wounding. A dry, corky decay with an anise odor begins in lower trunk and progresses upward. Leathery to corky sporophores 6 inches wide are white when young, gray to yellow with age.

Trichoderma

Deuteromycetes, Hyphomycetes

Conidia in heads on conidiophores divided into two or three tips, a single head on each tip; spores hyaline, one-celled.

Trichoderma viride. **Green Mold Rot, Cosmopolitan** on narcissus, also on shallot, garlic, occasional on citrus, but saprophytic. This fungus has an antibiotic or antagonistic effect on *Rhizoctonia, Pythium*, and other damping-off fungi and is quite helpful in reducing Armillaria root rot and crown rot due to *Sclerotium rolfsii*.
Trichoderma harzianum. **Fruit Rot** of apples in storage.

Trichothecium

Deuteromycetes, Hyphomycetes

Conidiophores long, unbranched; conidia two-celled, hyaline or bright, single, at apex of conidiophore; upper cell usually larger than basal cell; mostly saprophytic.

Trichothecium roseum. **Fruit, Storage Rot** on tomato, fig, celery, carrot, occasional on quince and pear; a pink mold. **Pink Mold Rot** on plum, nectarine and peach.

Ustulina

Ascomycetes, Xylariales

Stroma globoid, cupulate to pulvinate; carbonaceous, black, somewhat hollow; spores dark, one-celled.

Ustulina deusta. **White Heart Rot**, a brittle white rot with prominent black zones in butts of living hardwoods; prevalent on sugar maple sprouts. Black crusts appear on stumps, logs, and on flat cankered areas of American beech.

Valsa

► Cankers and Diebacks.

Valsa ambiens subsp. **leucostomoides**. Causing decay around holes of tapped sugar maples.

Leptographium (Verticicladiella)

Deuteromycetes, Hyphomyceres

Conidiophores upright, tall, brown, branched only near apex, penicillate; conidia (sympodulospores) hyaline, one-celled, ovoid to clavate, often curved, apical on sympodially formed new growing points, in slime droplets.

Leptographium abietinum (formerly *Verticicladiella abietina*). **Root Rot** on white pine.
Leptographium penicillata (formerly *Verticicladiella penicillata*. **Root Rot** on white pine.

Leptographium procera (formerly *Verticicladiella procera*. **Root Rot** and **Decline** of eastern white pine, sand pine and red pine.
Leptographium wagenerii (formerly *Verticicladiella wagenerii*. **Root Rot** on fir and pine.
Verticicladiella abietina (see *Leptographium abietinum*). **Root Rot** on white pine.
Verticicladiella penicillata (see *Leptographium penicillata*). **Root Rot** on white pine.
Leptographium procera (see *Verticicladiella procera*). **Root Rot** and **Decline** of eastern white pine, sand pine and red pine.
Leptographium wagenerii (see *Verticicladiella wagenerii*). **Root Rot** on fir and pine.

Xylaria

Ascomycetes, Xylariales

Stroma is upright, simple or branched; perithecia, immersed laterally, are produced after conidia; spores dark, one-celled.

Xylaria hypoxylon. **Root Rot** of hawthorn and gooseberry.
Xylaria mali. **Black Root Rot** of apple, also honey locust. Wood is soft, spongy, dirty white, with narrow conspicuous black zones forming fantastic patterns. Roots are covered with thin compact white mycelium, which changes to black incrustations. Fruiting bodies are dark brown to black, club-shaped, 1 to several inches high, united at the base, extending upward like a fan. The disease is not common, and where it does occur, only a few trees are killed.
Xylaria polymorpha. On decaying wood, identified by cylindrical thumb-like fruiting bodies.

RUSTS

Rust fungi belong to the Uredinales, a highly specialized order of the Basidiomycetes. In common with mushrooms they have spores of the sexual stage borne in fours on a club-shaped hypha known as a basidium, but apart from this they differ very decidedly from woody and fleshy Basidiomycetes. The term rust is applied both to the pathogen and to the disease it inflicts. There are more than 4000 species of rusts, all obligate parasites on ferns or seed plants. Many are heteroecious, completing their life cycle on two different kinds of plants; but some are autoecious (monoecious), having all spore forms on a single host species. There are only two families, Melampsoraceae and Pucciniaceae.

Many rusts show physiological specialization, the existence within a species of numerous strains or races that look alike but attack different varieties of crop plants, thus greatly complicating the problem of breeding for rust resistance. Rusts with a complete life cycle have five different spore forms, numbered 0 to IV.

0. *Pycniospores* (spermatia) formed in *pycnia* (spermagonia). The pycnia resemble pycnidia of Ascomycetes, are usually on upperside of leaves. They discharge one-celled pycniospores with drops of nectar, and these, usually distributed by insects attracted to the sweet secretion, function in fertilization.
I. *Aeciospores* (aecidiospores), one-celled, orange or yellow, formed, often in chains, in a cuplike sorus or *aecium*, which has a peridium (wall) opening at or beyond the surface of the host.
II. *Urediospores* (uredospores, summer spores, red rust spores), one-celled, walls spiny or warty, reddish brown, on stalks or in chains in a *uredium* (uredinium or uredosorus), over which the epidermis of the host is broken to free the spores. Resting II spores, formed by some rusts, have thicker and darker walls.
III. *Teliospores* (teleutospores, winter spores, black rust spores), one or more cells, in *telia* (teleuto sori), either on stalks, as in the family Pucciniaceae, or sessile, in crusts or cushions as in the Melampsoraceae.

IV. *Basidiospores* (sporidia) on a basidium or promycelium formed by the germinating teliospore. Basidium is usually divided transversely into four cells, with one sporidium formed from each cell at the tip of a sterigma.

In heteroecious rusts spore stages 0 and I are formed on one host and II and III on another, and are so indicated in the information given with each species. Stage IV always follows III on germination. Although most autoecious rusts have all spore forms, on one host, there are a few short-cycle (microcylic) rusts with some spore stages dropped out. For a detailed life history of a heteroecious rust, ► *Puccinia graminis*.

Gardeners frequently mistake a reddish discoloration of a leaf, perhaps due to spray injury or weather or a leaf-spot fungus, for rust. True rust is identified by the presence of rust-colored spores in powdery pustules or perhaps gelatinous horns. With rusts, the discoloration of tissue is yellowish, not red, and it is due to increased evaporation from the broken epidermis. Plants are often stunted.

Losses in food crops due to rust have been enormous since the beginning of history. The Romans had a festival to propitiate the rust gods. Now we try to do it by removing the alternate host, barberry to save wheat, black currants to save white pine; or by developing more and more resistant varieties for the ever increasing rust strains; or by the use of fungicides, classically sulfur, latterly some of the carbamates, and, in a few cases, antibiotics.

Achrotelium

Melampsoraceae. Telia on underside of leaves; spores one-celled at first, four-celled on germination, stalked.

Achrotelium lucumae. II, III on lucuma and egg fruit, Florida.

Aecidium

This is a form genus, a name applied to the aecial stage where the full cycle is unknown and 0 and I are the only spores. Aecia have a peridium and catenulate spores. There are many species.

Aecidium avocense. On poppy-mallow, probably aecial stage of *Puccinia avocensis*.

Aecidium conspersum. On houstonia and galium, Wisconsin.
Aecidium rubromaculans. On viburnum, Florida.

Angiospora

► *Physopella*.

Aplopsora

Melampsoraceae. Teliospores sessile, hyaline, one-celled, in a single layer; aecia unknown.
Aplopsora nyssae. On tupelo, II, III.

Baeodromus

Pucciniaceae. Spores one-celled; telia pulvinate, erumpent; short chains of spores.

Baeodromus californicus. On senecio, III.
Baeodromus eupatorii (see *Coleosporium steviae*). On eupatorium.
Coleosporium steviae (formerly *Baeodromus eupatorii*). On eupatorium.

Bubakia (Phakopsora)

Melampsoraceae. Telia indehiscent, lenticular, spores formed in irregular succession, one-celled. Uredia without peridium or paraphyses.

Bubakia erythroxylonis. On erythroxylon.

Caeoma

Form genus. Aecia with catenulate spores but no peridium.

Caeoma faulliana (see *Melampsora medusae*). **Needle Rust** on alpine fir. Aecia orange-yellow, on needles of current year.
Caeoma torreyae. On torreya, California.
Melampsora medusae (formerly *Caeoma faulliana*). **Needle Rust** on alpine fir. Aecia orange-yellow, on needles of current year.

Cerotelium

Pucciniaceae. Spores one-celled; teliospores in a many-layered mass; hyaline, not exserted through stomata; aecia with peridium; uredia with paraphyses; spores borne singly.

Cerotelium dicentrae. 0, I on bleeding heart; II, III on *Urticastrum*.
Cerotelium fici (*Physopella fici*). Fig Rust, II, III on common fig, Florida strangler fig and osage-orange, Alabama, Florida, Louisiana, Minnesota, South Carolina, Texas.

Chrysomyxa

Melampsoraceae. Teliospores in cylindrical or branching chains; promycelium exserted; urediospores typically in short chains; uredia without peridium.

Chrysomyxa arctostaphyli. On bearberry, III.
Chrysomyxa chiogenis. II, III on creeping snowberry; 0, I on spruce.
Chrysomyxa empetri. II, III on crowberry; 0, I on red and white spruce. Aecia on upper and lower surfaces of needles.
Chrysomyxa ilicina. II, III on American holly.
Chrysomyxa ledi. 0, I, on black, red and Norway spruce; II, III on underside of leaves of *Ledum* spp.
Chrysomyxa ledi var. **cassandrae**. Spruce Needle Rust. 0, I on black, red, blue and Engelmann spruce; II, III on bog rosemary (*Chamaedaphne*). May become epidemic on spruce, causing considerable defoliation.
Chrysomyxa ledi var. **groenlandici**. On Labrador-tea, Michigan, New Hampshire.
Chrysomyxa ledi var. **rhododendri**. II, III on rhododendron, Washington. A European rust first noted on Pacific Coast in 1954, apparently entering despite quarantine on nursery stock. Yellow uredia on leaves.
Chrysomyxa ledicola. 0, I on white, black red, blue, Engelmann, and Sitka spruce; II, III on upperside of leaves of *Ledum* spp. Spruce needles may be so discolored that trees appear yellow.
Chrysomyxa moneses. On Sitka spruce and moneses.
Chrysomyxa piperiana. 0, I on Sitka spruce; II, III on underside leaves of *Rhododendron californicum*, California, Oregon, Washington.
Chrysomyxa pirolata (*C. pyrolae*). 0, I on cones of black, blue, Engelmann,

Norway, red and white spruce; II, III on pyrola. Aecia are on upperside of cone scales; infected cones turn yellow, produce no seed.

Chrysomyxa weirii. **Spruce Needle Rust**. III on Engelmann and red spruce. Waxy orange to orange-brown elongate or elliptical telia occur on 1-year needles. This is the only spore stage known; teliospores can reinfect spruce.

Coleosporium

Melampsoraceae. Pycnia and aecia are on pines; uredia and telia on dicotyledons. Pycnia subepidermal or subcortical, flattish, linear, dehiscent by a slit; aecia on needles, erumpent, with prominent peridium, spores ellipsoid or globular; uredia erumpent, powdery without peridia; urediospores globose or oblong, catenulate, with verrucose (warty) walls; telia indehiscent, waxy, gelatinous on germination; spores sessile or obscurely catenulate, one-celled, smooth but with thick and gelatinous walls.

Coleosporium apocyanaceum. 0, I on loblolly, longleaf, and slash pines; II, III on *Amsonia* spp. in the Southeast.

Coleosporium asterum (*C. solidaginis*). **Needle Blister Rust** of pine. 0, I on all two- and three-needle pines in eastern United States; II, III on aster and goldenrod, on China aster (except far South), on golden aster (*Chrysopsis*), erigeron, grindelia, seriocarpus, and other composites. This blister rust on pine needles has pustules higher than they are long, in clusters or short rows. The rust is fairly common on ornamental pines in gardens, wintering on aster and related composites. Older needles of young pines may be severely infected, with white aecia conspicuous in spring and early summer. Aster leaves have bright orange-yellow spore pustules on undersurface. Destroy goldenrod near pines.

Coleosporium crowellii. III only stage known; on needles of pinon and limber pines, Arizona, Colorado, New Mexico, Utah, Nevada, and California.

Coleosporium delicatulum. **Pine Needle Rust**. 0, I on two- and three-needle pines; II, III on goldenrod and euthamia.

Coleosporium helianthi. 0, I on two- and three-needle pines, especially in the Southeast; II, III on silphium and parthenium.

Coleosporium helianthi. **Sunflower Rust**. 0, I on pitch and short-needle pines; II, III on wild and cultivated sunflower, Jerusalem artichoke and heliopsis. Sunflower leaves, with brown rust pustules, dry up and drop. Control is not easy.

Coleosporium ipomoeae. 0, I on southern and Chihuahua pines; II, III on moonflower, morning-glory, sweetpotato, jacquemontia, and quamoclit; most abundant in warmer regions. The uredia are orange-yellow, telia deep reddish orange on sweetpotato.
Coleosporium jonesii. 0, I on pinon pine; II, III on flowering currant and gooseberry.
Coleosporium lacinariae. 0, I on loblolly, longleaf, and pitch pines; II, III on liatris.
Coleosporium mentzeliae. On mentzelia.
Coleosporium minutum. 0, I on loblolly and spruce pines; II, III on forestiera.
Coleosporium pacificum. 0, I on Monterey, Coulter, and Jeffrey pines; II, III on marigold, sunflower, tarweed, and other composites.
Coleosporium pinicola. III on Virginia or scrub pine.
Coleosporium tussilaginis. 0, I on pitch, red, and Virginia pines; II, III on campanula, lysimachia, and specularia, Underside of bluebell leaves are covered with orange to reddish brown pustules. Leaves dry; plants are stunted.
Coleosporium tussilaginis. 0, I on Scotch pine; II, III on sow-thistle.
Coleosporium tussilaginis. 0, I, unknown; II, III on senecio.
Coleosporium vernoniae. 0, I on two- and three-needle pines in South; II, III on elephantopus.
Coleosporium vernoniae. 0, I on various two- and three-needle pines; II, III on ironweed.
Coleosporium viburni. 0, I, unknown; II, III on *Viburnum* spp.

Cronartium (Causing Blister Rusts)

Melampsoraceae. Heteroecious; pycnia and aecia on trunk and branches of pine; uredia, telia on herbaceous or woody dicotyledons.

Pycnia on stems, caeomoid, forming blisters beneath host cortical layer; dehiscent by longitudinal slits in bark; aecia on trunks, erumpent, with peridium sometimes dehiscent at apex, more often spliting irregularly or circularly at side; aeciospores ellipsoid with coarsely warted walls, sometimes with smooth spot on one side. Uredia on underside of leaves or on stems of herbaceous hosts; delicate peridium, dehiscent at first by a central pore; urediospores borne singly on pedicels, ellipsoidal with spiny walls; telia erumpent, often coming from uredia; catenulate, one-celled teliospores often form a extended cylindrical or filiform column, horny when dry (see Fig. 3.54).

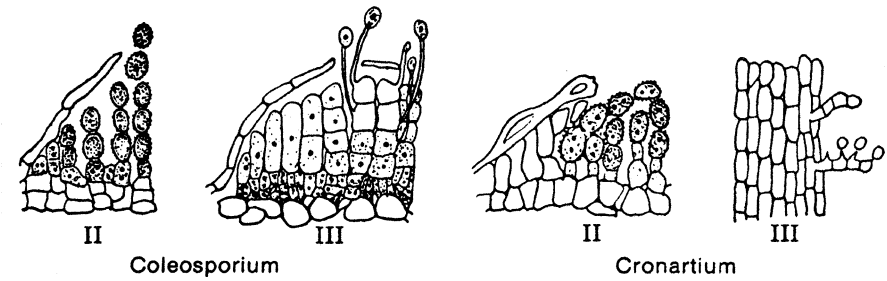

Figure 3.54 Pine Rusts. *Coleosporium asterum*, uredial (II) and telial (III) stages on aster, teliospores germinating *in situ*. *Cronartium ribicola*, II and III stages on currant

Blister rusts are characterized by swellings that are globose, subglobose, or fusiform, depending on species. A rust on a pine stem is invariably a *Cronartium*, although this stage has often gone under the name of *Peridermium*.

Cronartium appalachianum (*Peridermium appalachianum*). I on Virginia pine, North Carolina, Tennessee, Virginia, West Virginia. Girdling bark lesions with columnar aecia.

Cronartium coleosporioides. **Ponderosa Pine Rust**, widespread in Rocky Mountains; II, III on Indian paintbrush.

Cronartium coleosporioides (*C. filamentosum*). **Western Gall Rust**, **Paintbrush Blister Rust**. 0, I on lodgepole, ponderosa and Jeffrey pines, in West; II, III on Indian paintbrush, birds-beak, owls-clover and wood-betony. Slight swellings are formed on twigs, trunks, and branches; many lodgepole pine seedlings are killed.

Cronartium comandrae. **Comandra Blister Rust**. 0, I on ponderosa, Arizona, and lodgepole pines in West and pitch, mountain,jack, loblolly, Austrian, Scotch, and maritime pines in the East; II, III on bastard toadflax (*Comandra* spp.). Destructive effect is limited to distribution of toadflax, which is widespread but locally restricted to small areas. Ponderosa pine suffers most severely, with many seedlings and saplings destroyed; occasionally a large tree is attacked.

Cronartium comptoniae. **Sweet-Fern Blister Rust**. 0, I on two- and three-needle pines; II, III on sweet-fern and sweet gale in northern pine regions and south to North Carolina, and on Pacific wax-myrtle on Pacific Coast. Young pines may be girdled and killed, but are fairly safe after attaining a trunk diameter of 3 inches. Losses in nurseries and plantations are high, especially among lodgepole and ponderosa pines. Affected stems swell slightly near the base with long fusiform swellings or depressed streaks on

eastern hard pine; pitch oozes out from insect wounds in these areas. Killing of main stem often results in multiple-stemmed shrublike trees. Orange aecia appear on 3-year seedlings, preceded by pycnia the year before; spores are wind-borne many miles to herbaceous hosts.

Control. Remove *Myrica* species for several hundred yards around nurseries or pine plantations, and allow no large groups within a mile.

Cronartium conigenum. **Pine Cone Rust**. 0, I on cones of Chihuahua pine; II, III on oaks in Southwest. Cones develop in large galls producing aecia with distinct, erumpent peridium 2 or 3 years after infection.

Cronartium harknessii (see *Endocronartium harknessii*). **Western Gall Rust**. 0, I on Jeffrey, ponderosa, lodgepole, and digger pines; II, III on Indian paintbrush, lousewort, owls-clover, or omitted, with direct infection from pine to pine.

Cronartium occidentale. **Pinon Blister Rust**. 0, I in pinon and Mexican pinon; II, III on currant, gooseberry and flowering currant. This rust cannot be told from whitepine blister rust on *Ribes* hosts, but is differentiated by the type of pine attacked. Aecia on Mexican or singleleaf pinon are distinct sori; on pinon they form broad layers under bark.

Cronartium quercuum f. sp. **fusiforme**. **Rust** on pine.

Cronartium quercuum f. sp. **fusiforme**. **Southern Fusiform Rust**, 0, I on hard pines in southern states, especially loblolly, slash, and pitch pine; II, III on evergreen oaks on underside of leaves. Pine stems have pronounced spindle-shaped swellings, sometimes with witches' brooms. Branch infections that do not reach the main trunk are not serious, but those that go on to the trunk may kill the tree. Longleaf pines are rather resistant, and shortleaf *P. echinata* almost immune. Pines well spaced in good locations grow more rapidly and may have more rust than those in poor sites. It has also been reported on oaks.

Control. Prune branches yearly before swellings reach main stem.

Cronartium quercuum (*C. cerebrum*). **Eastern Gall Rust**. 0, I on pines, especially scrub and shortleaf in the South; II, III on chestnut, tanbark and oak. Globose to subglobose galls are formed on pine stems; in spring aecia break through the bark in more or less cerebroid (brainlike) arrangement.

Cronartium ribicola. **White Pine Blister Rust**. 0, I on eastern white pine from Maine to Virginia and Minnesota, on western white pine in the Pacific Northwest, on sugar pine in California; II, III on currant, flowering currant and gooseberry. Occurs also on limber pine in Northcentral and Southeastern Wyoming.

This dread disease is supposed to have originated in Asia, whence it spread to Europe, where the eastern white pine introduced from America was very susceptible. White pine blister rust was found in Russia in 1854, and by 1900 had spread over most of Europe. It was recorded on *Ribes* at Geneva, New York, in 1906, but probably was there some years previously. In 1909 it was found on pine, at which time it was learned that infected pines from a German nursery had been widely planted throughout the Northeast. The next year the disease reached Vancouver, British Columbia, in a shipment from a French nursery, whence it spread to Washington, Oregon, Northern California, Idaho, and western Montana. Thus from cheap stock brought in for forest planting has come one of our greatest forest hazards. Our present quarantine laws are designed to prevent such introductions.

The western white sugar and whitebark pines are even more susceptible to blister rust than eastern white pine; but in either case robust, dominant trees are more severely attacked, with frail individuals lightly infected. This however, is partly explained by more vigorous trees having more needles to receive spores. Of the *Ribes* species, black currant is most susceptible and dangerous. Cultivated red currants are somewhat resistant, causing a minimum of pine infection; Viking and Red Dutch varieties are practically immune. Wild gooseberries and skunk currant are highly susceptible in the Northeast, as are western black currant, stink currant, and red flowering currant. The greater the susceptibility of the *Ribes* species, the more spores are produced to inoculate pines, with proportionate damage.

Symptoms and Life History. When a spore arrives on a pine needle from a currant, the first sign of infection is a small golden yellow to reddish brown spot. The next season, or possibly in two years, the bark looks yellowish, often with an orange tinge to the margin of the discolored area, and there may be a spindle-shaped swelling. If such symptoms appear early in the season, pycnia are formed in bark by July or August; but if discoloration is delayed until midsummer, they appear the next year. The male fruiting bodies are small, honey yellow to brown patches, swelling to shallow blisters and rupturing to discharge drops of a yellowish, sweet liquid. After this is eaten by insects or washed away by rain, the lesions turn dark. The next spring or summer aecia push through the bark in the same region. These are white blisters, rupturing to free orange-yellow aeciospores, which are carried away by wind. The bark then dries out and cracks, with death of cambium and underlying wood. The disease has taken 3 to 6 years to reach this stage.

Production of aecia continues yearly until stem is killed beyond the lesion. Dead foliage assumes a conspicuous red-brown color. This "flag" of brown on a green background is the most conspicuous symptom of blister rust before death of the pine. Infection progresses downward from small to larger branches and into trunk. Swellings are not apparent on stems much over 2 inches in diameter on eastern white pine, but in the West they sometimes show up in stems 5 inches through. Larger limbs and trunks sometimes show constriction in the girdled area.

The aeciospores, large, ellipsoidal, with thick, warty walls, are carried by wind great distances to *Ribes* species (they cannot reinfect pine). They send their germ tubes into a currant or gooseberry leaf through stomata, and within 1 to 3 weeks pinhead-size blisters appear in clusters on yellowed leaf tissue. These uredia rupture to release large, ellipsoidal, yellow urediospores with thick, colorless walls and short, sharp but sparse spines. The spores are somewhat moist and sticky, and are windborne short distances to other *Ribes* bushes nearby. There may be up to seven generations in a summer, or the spores may remain viable over winter in uredia; this stage can infect only currant.

In late summer telia follow uredia in the same or new leaf lesions, appearing as short brown bristles on underside of leaves or looking like a coarse felt. Each felty bristle is composed of vertical rows of broad, spindle-shaped spores, which germinate *in situ* to a five-celled promycelium with each of the four upper cells bearing at the point of a sterigma a small, thin-walled, round basidiospore. This cannot reinfect currant and soon dies from exposure to the sun unless the wind blows it immediately to a pine needle. The effective range is around 300 feet except for spores from black currants, which can be carried a mile. The spores from pine to currant can be carried many miles, up to 300. Blister rust is more important at elevations of 1000 feet or over, where it is increased by lower temperatures and more rainfall.

Control. Eradication of the *Ribes* host is definitely effective in controlling white pine blister rust. This means complete removal of black currants and local removal of cultivated red and wild currants and gooseberries within 300 or 900 feet of pines, according to state regulations, taking care to get all the root system capable of resprouting.

Blister rust is seldom found on ornamental pines in cities; the smoke and fumes are unfavorable to the fungus. Elsewhere valuable ornamentals can be saved by cutting off infected branches and cleaning out trunk infection, stripping off diseased bark and a 2-inch side margin, 4-inch margin at top

and bottom, of healthy bark. If the cankers are nearer to the trunk than 6 inches, the bark should be excised around the branch stub. The red currant Viking is immune to blister rust, and a couple of black currant hybrids are resistant. Some white pines are exhibiting resistance.

Cronartium stalactiforme (see *Peridermium stalactiforme*). 0, I on lodgepole pines in Rocky Mountain regions; II, III on Indian paintbrush.

Cronartium strobilinum. **Pine Cone Rust**. 0, I on cones of longleaf and slash pines; II, III on evergreen oak. Cones are swollen, reddish; 25 to 90% drop.

Endocronartium harknessii (formerly *Cronartium harknessii*). **Western Gall Rust**. 0, I on Jeffrey, ponderosa, lodgepole, and digger pines; II, III on Indian paintbrush, lousewort, owls-clover, or omitted, with direct infection from pine to pine. Galls are globose, with large, confluent aecia; bark sloughs off in large scales; witches' brooms are formed. A variety of this species, alternate stage unknown, occurs on Monterey and knobcone pines in California.

Control. Remove trees with galls for a distance of 300 yards around nurseries. Do not ship infected trees from nurseries.

Peridermium stalactiforme (formerly *Cronartium stalactiforme*). 0, I on lodgepole pines in Rocky Mountain regions; II, III on Indian paintbrush. The rust enters pine trunks through small twigs, producing diamond-shaped lesions that elongate an average of 7 inches a year, but grow laterally less than 1/2 inch. Removal of diseased trees is the only known control.

Cumminsiella

Pucciniaceae. Autoecious; teliospores two-celled; pycnia and other sori subepidermal; aecia cupulate.

Cumminsiella mirabilissima. 0, I, II, III on barberry and mahonia in the West, Arizona, California, Colorado, Idaho, Montana, Nebraska, New Mexico.

Cumminsiella texana. On barberry, Texas.

Desmella

Pucciniaceae. Uredia and telia subepidermal, protruding in tufts; uredia without peridium or paraphyses. Spores globoid, on pedicels, two-celled.

Desmella aneimiae. On Boston fern, Florida.

Endocronartium

Badisiomycete, Uredinales, Pucciniaceae.

Endocronartium harknessii. **Western Gall Rust or Pine-Pine Gall Rust** on pine.

Endophyllum

Pucciniaceae. Teliospores in form of aeciospores; telia with cupulate peridium.

Endophyllum sempervivi. III on houseleek and hen-and-chickens. Succulent leaves may be covered with reddish pustules. This is not common, but may be serious. Clean out infected parts.
Endophyllum tuberculatum. III on hollyhock and checkermallow.

Frommeella

Pucciniaceae. Teliospores two-to many-septate; aecia and uredia erumpent.

Frommeella duchesneae. II, III on mock-strawberry, false strawberry, or Aztec Indian berry.

Arthuriomyces (Gymnoconia)

Pucciniaceae. Uredia lacking; aecia present but without peridium; teliospores two-celled, one pore in each cell.

Arthuriomyces peckianus (formerly *Gymnoconia peckiana* (*G. interstitialis*). **Orange Rust** of blackberry. 0, I, III on blackberry, dewberry and

black raspberry, first described from eastern United States in 1822, present from Canada to Florida and from Alaska to southern California. Very bright orange spores cover underside of leaves in spring. The mycelium is perennial in the bush, living throughout the year between cells of the stem, crown, and roots, each season invading new tissue as new growth begins. Shoots may be bunched, often with a witches' broom effect; plants are dwarfed. Spraying is useless; infected plants never recover. Plant only healthy stock, obtained from a nursery where the disease is unknown. Remove infected plants showing upright habit of growth, yellow color, and glistening yellowish dots of pycnia before the orange spore stage appears. Blackberry varieties Eldorado, Orange Evergreen, Russell, Snyder, Ebony King, dewberry *Leucretia*, and boysenberries are quite resistant.

Gymnoconia peckiana (**G. interstitialis**) (see *Arthuriomyces peckianus*). **Orange Rust** of blackberry. 0, I, III on blackberry, dewberry and black raspberry, first described from eastern United States in 1822, present from Canada to Florida and from Alaska to southern California.

Gymnosporangium

Pucciniaceae. All but one species heteroecious. Picnia and aecia usually on trees and shrubs of the apple family; telia confined to cedars and junipers except for one species on cypress; uredia wanting. Teliospores thick- or thin-walled, various in form but mostly flat, tongue-shaped, expanding greatly when moistened, usually with two cells; walls smooth, one to several pores in each cell; pedicel colorless, usually with outer portion swelling and becoming jellylike when moistened. Aecia are highly differentiated and conspicuous, with catenulate aeciospores, deeply colored with verrucose walls (see Fig. 3.55).

The life cycle is similar in all juniper leaf rusts. In early summer, small, slightly swollen spots appear on leaves of the pomaceous host, then small raised specks in this area on the upper surface, openings of flask-shaped pycnia embedded in leaf tissue. After exuding an orange liquid containing pycniospores, the specks are black. Later, aecia push out on the underside of the same spots as dingy white columns, rostelia, with the outer coating rupturing to release a powdery mass of yellow to brown aeciospores. The ruptured segments sometimes make the open aecium look star-shaped, but in the common cedar-apple rust aecia are cup-shaped. Aecia are also formed on fruit and tender green stems. Aeciospores released during summer are wind-borne to junipers. Mycelium winters in the juniper needle or stem, and in spring galls are started that take a year or more to produce teliospores in cushions or horns.

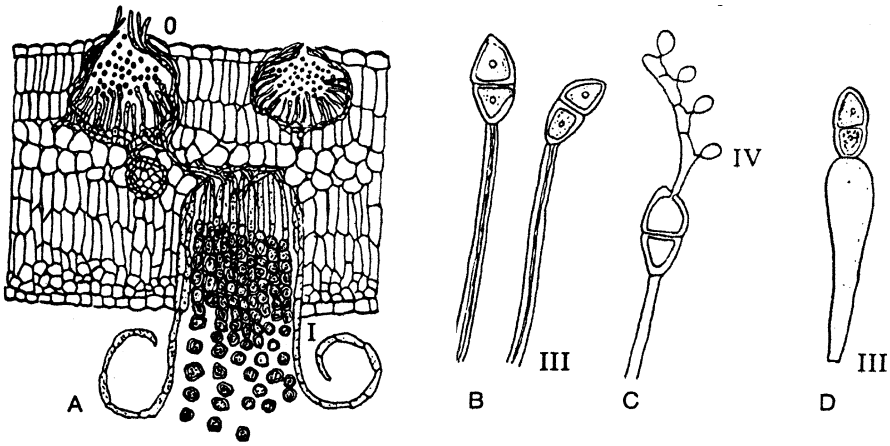

Figure 3.55 Cedar-Apple Rust. *Gymnosporangium juniperi-virginianae*. **A** section through crabapple leaf with pycnidia (*0*) on upper surface and aecium (*I*) with prominent peridium and aeciospores in chains on undersurface; **B** two-celled teliospores on gelatinous stalks, which help form the jellylike telial horns on cedar galls; **C**, teliospores germinating with a promycelium and basidiospores; **D** teliospore of *G. clavipes*, the quince rust

Gymnosporangium bermudianum. 0, I, III on stems of eastern and southern red-cedar in the Gulf states. No alternate host; aecia precede telia on small galls.

Gymnosporangium bethelii. III on Rocky Mountain juniper; 0, I on fruits of hawthorn.

Gymnosporangium bethelii. III on stems of prostrate and Rocky Mountain junipers; 0, I on leaves, fruit of hawthorn. Telia are 3 to 4 mm high on irregular galls on cedar twigs and branches.

Gymnosporangium biseptatum. III on stems of *Chamaecyparis thyoides*; 0, I on amelanchier. Spindle-shaped swelling in stem; trees may die.

Gymnosporangium clavariiforme. III on common and mountain juniper; 0, I on chokeberry, amelanchier, pear and quince. Slender telia 5 to 10 mm high produced on long fusiform swellings on branches.

Gymnosporangium clavipes. Quince Rust. III on eastern red-cedar, dwarf, mountain, and prostrate junipers; 0, I on fruits and young stems of amelanchier, apple, chokeberry, crabapple, hawthorn, mountain-ash, quince, Japanese quince and pear. Short slight swellings, somewhat spindle-shaped, occur in cedar twigs and branches, many of which die. On the main trunk, infected areas are black rough patches or rings around the bark. Mycelium is perennial, confined to the outer layer of living bark; it can sometimes be

scraped out by scraping the bark. On pomaceous hosts, the disease is most frequent on fruits, often causing distortion. Rust sometimes affects twig and buds but seldom leaves. Aecia are particularly prominent on hips of English hawthorn, with long whitish perithecium around orange spores.
Control. Some apple varieties susceptible to apple rust are rather resistant to quince rust, including Jonathan, Rome, Ben, Davis, and Wealthy. Red Delicious is quite susceptible. Destroy cedars in neighborhood of orchards; spray as for apple rust.
Gymnosporangium confusum. III on Savin Juniper; 0, I on hawthorn.
Gymnosporangium cornutum (*G. auriantiacum*). **Juniper Gall Rust**. III on leaves and stems of common juniper; 0, I on mountain-ash.
Gymnosporangium cunninghamianum. III on Arizona cypress; 0, I on amelanchier.
Gymnosporangium davisii. III on mountain and common juniper; 0, I on leaves of red and black chokecherry. Telia are usually on upper surface of needles, sometimes at base of stems.
Gymnosporangium effusum. III on eastern red-cedar; 0, I on chokeberry. Fusiform swellings on cedar trunk and branches.
Gymnosporangium ellisii. **Witches' Broom Rust**. III on southern white cedar (*Chamaecyparis*); 0, I on sweet-fern, gale, bayberry, wax-myrtle leaves, fruits and young stems. Aecia are cluster cups; telia are cylindrical, filiform, 3 to 6 mm high, appearing on leaf blade or axil the first season after infection, thereafter only on stems, invading inner bark and wood. Witches' brooms are abundant; even large trees die if heavily broomed.
Gymnosporangium exiguum. III on leaves of alligator and Mexican junipers, eastern red-cedar; 0, I on leaves, fruits of hawthorn.
Gymnosporangium exterum. III on stems of eastern red-cedar; 0, I on gillenia. Flattened telia anastomose over short fusiform swellings with roughened bark on cedars. Also galls on stems of juniper.
Gymnosporangium floriforme. III on red-cedar; 0, I on leaves of hawthorn. Cedar galls are small.
Gymnosporangium fraternum (*G. transformans*). III gall on *Chamaecyparis thyoides*; 0, I on chokeberry.
Gymnosporangium globosum. **Hawthorn Rust**, III general on eastem red-cedar, also on dwarf, prostrate, and Rocky Mountain junipers; 0, I mostly on hawthorn, also on apple, crabapple, pear and mountain-ash. Leaf galls on cedar are very similar to those of common cedar-apple rust, but are smaller, seldom over 1/2 inch, nearer mahogany red in color, and not perennial, pro-

ducing telial horns one season only. Apple and pear foliage may be slightly affected but not the fruit; aecia are common on hawthorn pips.

Gymnosporangium gracile. III **Witches' Broom** on juniper; 0, I on hawthorn, quince, and shadbush.

Gymnosporangium asiaticum. III on leaves of Chinese juniper; 0, I on Chinese flowering quince and pear.

Gymnosporangium harknessianum. III on western juniper; 0, I on amelanchier, chiefly on fruits, sometimes stems. Papery margins of aecia are usually long.

Gymnosporangium hyalinum. III on southern white-cedar; 0, I on hawthorn and pear leaves. Slight swellings are formed on small twigs and branches of white-cedar.

Gymnosporangium inconspicuum. III on Utah juniper; 0, I on fruits, mostly of amelanchier and squaw-apple. Juniper leaves turn yellow; rarely telia appear on branches.

Gymnosporangium japonicum (*G. photiniae*). III gall on stems of Chinese juniper; 0, I on photinia.

Gymnosporangium juniperi-virginianae. **Cedar-Apple Rust**. III general on red cedar, eastern and southern, on prostrate and Rocky Mountain junipers; 0, I general on apple and crabapple east of Great Plains. The fungus is a native of North America and does not occur elsewhere. It is more important commercially in the apple-growing regions of the Virginias and Carolinas and certain states in the Mississippi Valley. It is important in many areas on ornamental crabapples in home plantings.

The cedar "apples" or galls vary from 1/16 inch to over 2 inches across. Leaves are infected during the summer, and by the next June a small, greenish brown swelling appears on upper or inner leaf surface. This enlarges until by autumn the leaf has turned into a chocolate brown, somewhat kidney-shaped gall covered with small circular depressions. The next spring in moist weather orange telial horns are put forth from the pocketlike depressions. The teliospores are enveloped in a gelatinous material that swells vastly, a gall covered with horns sometimes reaching the size of a small orange. They germinate in place to produce the basidiospores, which are carried by wind to infect apple or other deciduous host.

By midsummer, apple leaves show yellow areas with amber pustules on upper surface; but after pycnia have exuded drops of sticky liquid,they appear as black dots in a rather reddish circle. On the undersurface of these spots small cups are formed, with recurved fimbriate margins. These aecia may

also appear near stem end of apples and are common on swollen twigs of crabapple. Spores from these cups are blown back to the cedar in late summer, the entire cycle thus taking 2 years, 18 to 20 months on the cedar, 4 to 6 on the apple host.

Chief injury is to the apple host, the rust causing premature defoliation, dwarfing and poor-quality fruit. On very susceptible crabapples, such as Bechtel's crab, repeated infection may cause death of the branches or of the entire tree. All our native crabapples are susceptible; most Asiatic varieties are resistant.

Control. Care in planning is most important. Don't let your landscape architect or gardener put cedars and native crabapples or hawthorns close together. Keep them separated as far as possible with a windbreak in between of some tall nonsusceptible host. Some states have laws prohibiting red-cedars within a mile of commercial apple orchards, but for practical garden purposes a few hundred yards is sufficient, the danger markedly decreasing with distance, especially with a house or hedge as a windbreak.

If junipers are already planted, it is possible in late winter to go over small specimens and remove galls before spore horns are formed. Spraying in spring inhibits telial development and germination of teliospores. Spray red-cedars in August to prevent infection from crabapples.

Fairly resistant apple varieties are Baldwin, Delicious, Rhode Island and North-western Greening, Franklin, Melrose, Red Astrachan, Stayman, and Transparent. Avoid susceptible Jonathan, Rome, Wealthy, and York Imperial. Most junipers susceptible to apple rusts are cultivars of *Juniperus virginiana* and *J. scopulorum*. Many cultivars of *J. chinensis* and *J. horizontalis* are resistant, and there are even some resistant forms of *J. virginiana.*

Gymnosporangium kernianum. III on alligator, Utah, and western junipers; 0, I on amelanchier and pear. Telia arise between leaves on green twigs, but mycelium is perennial in stems, causing dense witches' brooms 6 to 18 inches in diameter.

Gymnosporangium libocedri. III on incense cedar; 0, I on leaves, fruits, of amelanchier and hawthorn, also apple, crabapple, pear, quince, Japanese quince and mountain-ash. Aecium is a cluster cup on foliage; telia are always on leaves; witches' brooms and swellings are produced on branches, rarely on trunks. The fungus is said to persist in the mycelial stage up to 200 years.

Gymnosporangium multiporum. III on stems of western, one -seed, and Utah juniper between leaves; 0, I unknown.

Gymnosporangium nelsonii. III on juniper and red-cedar; 0, I on leaves of amelanchier.

Gymnosporangium nelsonii. III on one-seed, prostrate, Rocky Mountain, Utah, and western junipers; 0, I on hawthorn, quince, Oregon crab, pear, squaw-apple and Pacific mountain-ash. Galls are firm, woody, round, up to 2 inches in diameter.

Gymnosporangium nidus-avis. Witches' Broom Rust. III on eastern and southern red-cedars, on prostrate and Rocky Mountain junipers; 0, I on fruit, young stems, leaves of apple, hawthorn, mountain-ash, quince, Japanese quince, amelanchier or serviceberry. Trunks and branches of large trees have witches' brooms and long spindle-shaped swellings. Aecia are on both leaf surfaces.

Gymnosporangium nootkatense. Gall Rust. II, III on Alaska cedar; 0, I on mountain-ash, and Oregon crabapple. This is the only *Gymnosporangium* species with uredial stage. Uredia are bright orange fading to pale yellow; teliospores appear later in the same pustules. Aecia are cluster cups.

Gymnosporangium speciosum. III on alligator, one-seed, and Utah junipers; 0,I on leaves of syringa (*Philadelphus*) and fendlera. Telia are in longitudinal rows on long fusiform swellings on juniper branches, which are girdled and die. In severe infections the whole tree dies.

Gymnosporangium trachysorum. III on stem of eastern red-cedar; 0, I on hawthorn leaves. Swellings on cedar are abruptly fusiform to globoid with prominent telia 6 to 10 mm high.

Gymnosporangium tremelloides (*G. juniperinum*). III, stem gall on mountain juniper; 0, 1 on Pacific mountain-ash. On smaller branches swellings are subglobose galls up to 3/4 inch in diameter; hemispherical swellings on larger branches are covered with flattened telia.

Gymnosporangium vauqueliniae. Witches' Broom Rust. III on one-seed juniper; 0, I on *Vauquelinia californica*. This rust is the only *Gymnosporangium* causing witches' brooms on the aecial host.

Hyalopsora

Melampsoraceae. Telia on ferns, teliospores several-celled, in epidemis; urediospores of two kinds, with pores.

Hyalopsora aspidiotus. Fir-Fern Rust. 0, I on balsam fir; II, III on oak fern

(*Phegopteris dryopteris*). Pycnia are slightly raised orange-yellow spots on needles; aecia are yellow to white, columnar, on 2-year needles.
Hyalopsora cheilanthis. **Fir-Fern Rust**. 0, I on balsam fir; II, III on rock brake, parsley fern, and cliff brake.
Hyalopsora polypodii. **Fir-Fern Rust**. General in northern and western states on polypody fern and woodsia.

Kuehneola

Puciniaceae. Teliospores two- to many-celled; wall faintly colored or colorless.

Kuehneola malvicola. II, III on hibiscus and malvaviscus.
Kuehneola uredinis. **Yellow Rust**, **Cane Rust**. 0, I, II, III on blackberry, dewberry, and raspberry. The disease appears to be increasingly prevalent, especially on leaves, but there is a great difference in varietal susceptibility. Eldorado, Foster,Jumbo, Lawton blackberries are highly susceptible; Nanti-choke, Austin Thornless, Boysen Brainerd, Burbank Thornless, Jersey Black are resistant. European varieties are generally resistant.

Kunkelia

Pucciniaceae. Pycnia subcuticular; telia subepidemal, caeomoid; teliospores catenulate, one-celled.

Gymnoconia nitens (formerly *Kunkelia nitens*). **Short-Cycle Orange Rust** of blackberry. I, general on blackberry but more common in the South and West, also on dewberry and black,but not red raspberry. This is a perennial rust, a systemic disease with only the aecial stage present. Underside of leaves may be covered with quantities of orange-yellow spores. Remove infected bushes.
Kunkelia nitens (see *Gymnoconia nitens*). **Short-Cycle Orange Rust** of blackberry.

Melampsora

Melampsoraceae. Telia more or less indefinite; teliospores sessile, subcuticular or subepidermal, forming crusts of a single layer; aecia when present with rudimentary peridium; uredia erumpent, pulverulent; spores globoid or ellipsoid, single on pedicels.

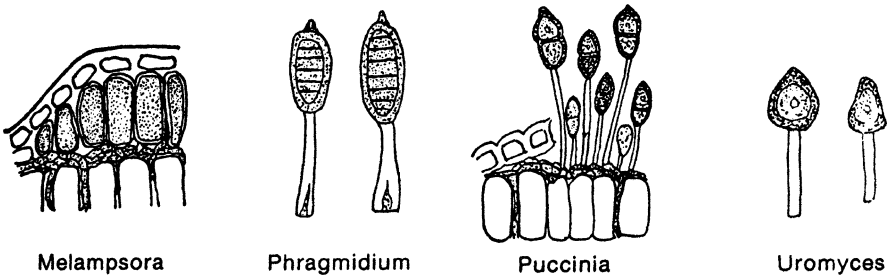

Figure 3.56 Teliospores. *Melampsora*, sessile in crust under host epidermis; *Phragmidium*, stalked, with several cells; *Puccinia*, stalked, two-celled; *Uromyces*, stalked, one-celled

Species heteroecious when telia are on woody plants; autoecious if telia are on herbaceous plants (Fig. 3.56).

Malampsora abieti-capraearum. **Fir-Willow Rust**. 0, I on balsam, white, and alpine firs; II, III on willows, widespread. Yellow spots on willow leaves in early summer are followed by dark pustules when the telial stage is produced. There may be some defoliation.

Melampsora abietis-canadensis. **Hemlock-Poplar Rust**. 0, I on eastern hemlock; II, III on various poplars. Cones have golden powdery masses of spores over the surface; later shrivel, turn black, and hang as mummies; no viable seed produced. Uredia are golden powdery pustules on undersurface of poplar leaves; in late summer telia are formed in orange-yellow crusts that change to black; in spring basidiospores reinfect hemlock.

Melampsora arctica. 0, I on saxifrage; II, III on willow.

Melampsora farlowii. **Needle And Cone Rust** of hemlock. 0, I unknown; III on hemlock. Reddish slightly raised telia are on undersurface of needles, shoots of the current year, and on cones. Young shoots may be twisted and killed. Injury may occur in nurseries and in ornamental hedges.

Melampsora hypericorum (*Mesopsora hypericorum*). On St. Johnswort, Montana.

Melampsora larici-populina. **Rust**; 0, I, on pine and larch; II, III, on poplar.

Melampsora medusae. **Douglas-Fir Needle Rust**. 0, I on Douglas-fir, big-cone spruce; II, III on native poplars. Pycnia are on upper surface of current-year needles; aecia, of the caeoma type, are orange-yellow on the undersurface. The rust is often epidemic on young trees but with little permanent ill effect.

Melampsora medusae. **Larch Needle Rust**. 0, I on larch in northeastern states; II, III on native and introduced poplars except in far South.

Melampsora medusae f. sp. **deltoidae**. **Rust**; 0, I on Douglas fir, pine and larch; II, III, on poplar.
Melampsora occidentalis. **Poplar Rust**. 0, I unknown; II, III on native poplars in the West.
Melampsora paradoxa (*M. bigelowii*). **Larch-Willow Rust**. 0, I on larch; II, III on many species of willow. The damage to larch is insignificant. The fungus winters on willow as mycelium in catkins, terminal buds, and young stems and can maintain itself on willow in the uredial stage without larches.
Melampsora ribesii-purpureae. 0, I on currant, flowering currant and gooseberry; II, III on willow species.

Melampsorella

Melampsoraceae. Heteroecious on fir, spruce, and dicotyledons; pycnia subcuticular, aecia and uredia subepidermal, telia in epidemal cells. Only one species in United States.

Melampsorella caryophyllacearum (*M. cerastii*). **Yellow Witches' Broom Rust**. 0, I on many firs; II, III on chickweed. Infected evergreen branches develop numerous upright lateral shoots from one point, forming a compact witches' broom; twigs are dwarfed, and needles turn yellow and drop, leaving brooms bare. The fungus is perennial in stems, and shoots develop with yellow leaves. Pycnia appear in raised orange spots on both surfaces of dwarfed leaves in spring; aecia form in summer on underside, in two rows of orange blisters. The disease is seldom serious enough for control measures. In forest practice remove trees with main stem infections early in life of the stand.

Melampsoridium

Melampsoraceae. Heteroecious, on larch and dicotyledonous shrubs and trees; pycnia subcuticular; other sori subepidermal; teliospores sessile, one-celled.

Melampsoridium betulinum. **Birch Leaf Rust**. 0, I on larch; II, III on birches. Uredia on underside of birch leaves are small reddish yellow powdery pustules, followed later in summer by telia, first waxy yellow, then dark brown to nearly black.

Milesina

Melampsoraceae. Heteroecious on firs and ferns. All spores are colorless; urediospores obovate or laceolate; teliospores in epidemal cells.

Milesina fructuosa. 0, I on balsam fir; II, III on *Dryopteris* spp. Aecia are white on current needles, maturing by midsummer.

Milesina laeviuscula. **Needle Rust**. 0, I on grand fir; II, III on licorice fern, in West.

Milesina marginalis. 0, I on balsam fir; II, III on *Dryopteris marginalis*. Pycnia are on both sides of needles, aecia of needles of current year, maturing by midsummer.

Milesina pycnograndis (*M. polypodophila*). 0, I on balsam fir; II, III on *Polypodium virginianum*. Hyphae are perennial in needles and small stems of balsam fir; aecia on needles 3 to 9 years old.

Nyssopsora

Puccinaceae. Autoecious; teliospore with three cells.

Nyssopsora clavellosa. III on *Aralia hispida*.

Peridermium

A form genus with 0, I, on Gymnosperms. Aecia have peridia and are cylindrical, tonguelike or bullate.

Peridermium bethelii. On dwarf mistletoe.

Peridermium ornamentale. 0, I on white, alpine, and noble firs.

Peridermium rugosum. 0, I on Pacific silver and lowland white firs.

Phakopsora

Melampsoraceae. Telia indehiscent, lenticular; spores formed in irregular succession, not in chains.

Phakopsora cherimoliae. On cherimoya.

Phakopsora jatrophicola. On cassava.

Phakopsora pachyrhizi. On soybean.
Phakopsora zizyphi-vulgaris. On *Zizyphus jujuba*, Florida.

Phragmidium

Pucciniaceae. Autoecious. Pycnia subcuticular, other sori subepidermal; aecia caeomoid; teliospores large, conspicuous, of one to ten or more cells, each with two or three lateral pores; walls somewhat layered, inner layer colored, outer nearly colorless, smooth or verrucose; pedicel colorless except near spore; often swelling in lower portion (see Fig. 3.56). Aecia with catenulate globoid or ellipsoid verrucose spores; uredia when present circled with paraphyses; urediospores single on pedicels, walls verrucose or echinulate with indistinct scattered pores.

Phragmidium americanum. 0, I, II, III on leaves of native and cultivated roses. Teliospores with eight to eleven cells.
Phragmidium fusiforme (*P. rosae-acicularis*). 0, I, II, III on several hosts species. Teliospores with five to eleven cells, walls chocolate brown, verrucose.
Phragmidium montivagum. 0, I, II, III on many species of roses. Teliospores with six to nine cells.
Phragmidium mucronatum (*P. disciflorum*). **Leaf Rust of Rose**. 0, I on leaves and stems; II, III on leaves of cultivated roses, eastern states to the Rocky Mountains and on the Pacific Coast. This is the common rust of hybrid teas and other roses with large, firm leaflets. It is not much of a problem in the East, although sometimes found in New York and New England gardens, but it is a serious menace along the Pacific Coast. Aecia appear on leaves as small, roughly circular spots, 1/25 inch across, bright orange on the underside of leaf, from the spore masses, light yellow on the upper surface, sometimes bordered with a narrow green zone. Leaf lesions may be slightly cup-shaped viewed from the upper surface. Stem lesions are long and narrow. The summer uredial stage has reddish orange spores in very small spots, 1/50-inch, over underside of leaves. This stage may repeat every 10 to 14 days in favorable weather, with wilting and defoliation. In mild climates the uredial stage continues; in cooler areas the telial stage is formed toward autumn – black pustules of stalked dark spores, rough, with a point, five to nine cells.
The leaf surface must be continuously wet for 4 hours for rust spores to germinate and enter the leaf; this means liquid water and not high humidity as with mildews. High summer temperatures adversely affect infection,

summer spores retaining viability for only a week at 80°F. In southern California temperatures are uniformly favorable for rose rust, and from October to April there is sufficient rainfall. In drier months fog may provide requisite moisture.

Control. Removing infected leaves during the season and all old leaves left at the time of winter or early spring pruning may be somewhat helpful.

Phragmidium rosae-arkansanae. 0, I, II, III on *Rosa arkansana* and *R. suffulta*. Teliospores with five to eight cells.

Phragmidium rosae-californicae. 0, I, II, III on many rose species. Teliospores with eight to eleven cells.

Phragmidium rosicola. III on *Rosa engelmanii* and *R. suffulta*. Teliospores one-celled, nearly round.

Phragmidium rubi-idaei. **Leaf and Cane Rust** of raspberry; **Western Yellow Rust**, general but important only in the Pacific Northwest. 0, I, II, III on red rasberries, sometimes black but not on blackberries. Small, light yellow spore pustules appear in young leaves, with black teliospores following in the same spots later in the season. Deep, cankerous lesions are formed on canes in the fruiting year, Cuthbert variety being particularly susceptible. Spring infection probably comes from sporidia formed in telia on fallen leaves. A dormant spray may be helpful, along with cleaning out infected canes at winter pruning.

Phragmidium speciosum. 0, I on stems and leaves, III on stems of cultivated and native roses, throughout United States except far South.

Phragmidium subcorticium. Obsolete name. Some specimens formerly recorded as this species belong to *P. mucronatum*, others to *P. rosae-pimpinellifoliae*.

Phragmidium tuberculatum. On *Rosa* sp. Connecticut and Alaska.

Phragmopyxis

Pucciniaceae. Teliospores colored, two- to many-septate; wall three-layered, the middle layer swelling in water; aecia, uredia, and telia with a border of paraphyses.

Phragmopyxis acuminata. 0, III on *Coursetia*.

Physopella (Angiopsora)

Pucciniaceae. Only uredia and telia known. Telia indehiscent, lenticular; teliospores in chains.

Physopella ampelopsidis (*Phakopsora vitis*). On ampelopsis and grape, Florida.
Physopella compressa. On paspalum, southern ornamental grass.

Pileolaria

Pucciniaceae. Autoecious, on members of family Anacardiaceae. Teliospores stipitate, dark, with pores, one-celled; pycnia subcuticular; uredia present.

Pileolaria cotini-coggyriae. On smoke tree.
Pileolaria patzcuarensis. 0, I, II, III on sumac.

Prospodium

Pucciniaceae. Autoecious on Bignoniaceae and Verbenaceae in warm climates.

Prospodium appendiculatum. On tecoma, Florida, Texas.
Prospodium lippiae. On lippiae, Arizona.
Prospodium plagiopus. On tabebuia, Florida.
Prospodium transformans. On tecoma, Florida.

Puccinia

Pucciniaceae. A very large genus, comprising nearly half of all known rusts; autoecious and heteroecious. Teliospores smooth, two-celled with apical pores, firm pedicels, colored; aecia cluster cups with peridium (see Fig. 3.56). The species listed here are a small selection of those on garden plants; others are listed in host section.

Puccinia acroptili. Rust on *Centaurea*.
Puccinia allii (*P. porri*). Autoecious on onion, garlic and shallot, but 0, I stages rare. Occasional on cultivated onion, more common on garlic, wild garlic, and wild onion. Uredia are yellowish, telia black.
Puccinia amphigena (*Aecidium yuccae*). On yucca.
Puccinia andropogonis, with various strains. 0, I on lupine, Indian paintbrush and turtlehead; II, III on andropogon.
Puccinia antirrhini. Snapdragon Rust. II, III general on snapdragon, also on linaria, corydylanthus; 0, I unknown. Pustules of spores on underside of leaves are chocolate brown, often in concentric circles (see Fig. 3.57). The

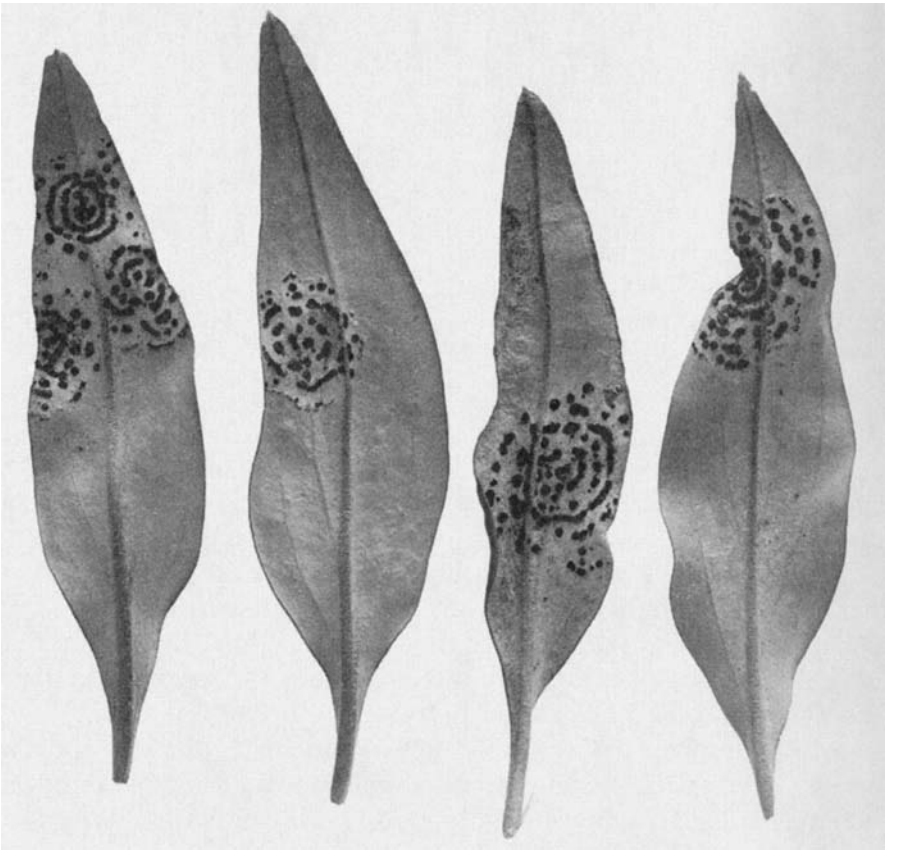

Figure 3.57 Rust on Snapdragon

area over the pustule is pale or yellow on upper surface. Spores also appear on stems; there is a drying and stunting of whole plant. The rust is spread by wind-blown spores and on cuttings. For infection, plants need to be wet with rain or dew 6 to 8 hours with day temperatures around 70° to 75°F. Spores are killed above 94°F. There are at least two races.

Control. Purchase only rust-resistant variety. Bordeaux mixture controls secondary fungi following rust but not the rust itself. Sulfur dust is still useful, or a spray made by adding 1 ounce rosin soap to a gallon of water and then adding 1 ounce dry lime sulfur.

Puccinia arachidis. **Peanut Rust**, occasional in Alabama, Florida, Texas.

Puccinia aristidae and varieties. II, III on wild grasses, *Aristides* and *Distichlis*; 0, I on eriogonum, greasewood, beet, spinach, western wallflower, garden cress, radish, California bluebell, heliotrope, cleome, primrose, sandverbena, and others.

Puccinia asparagi. **Asparagus Rust**. II, III general on susceptible varieties; 0, I not reported in natural infections. Also on onion. Asparagus rust reached America in 1896 from Europe and spread with devastating suddenness from Boston and New Jersey to California, reaching there by 1912, one of the fastest cases of disease spread in our history. If tops are attacked several years in succession, the root system is so weakened that shoots fail to appear in spring or are culls.

The first symptom is a browning or reddening of smaller twigs and needles, with the discolored area spreading rapidly until the whole planting looks as if it had ripened prematurely. The reddish color is due to numerous small pustules of urediospores that give off a dusty cloud when touched. These appear in successive generations until autumn, or a spell of drought, when they are replaced by black teliospores, either in the same or a new fruiting body. They remain on old stems until spring, germinating then to infect new shoots as they emerge from the ground.

Control. For a long time resistant varieties Mary Washington and Martha Washington were the answer to the rust problem, but the fungus has developed resistant strains. Waltham Washington, Seneca Washington, and California 500 have some resistance. Clean up volunteer or wild asparagus around beds. A parasitic fungus, *Darluca filum*, helps keep rust in check.

Puccinia brachypodii var. **poae-nemoralis** (formerly *Puccinia poae-nemoralis* (Syn. *P. poae-sudeticae*)). **Bluegrass Leaf Rust**, **Yellow Leaf Rust**. II, III on turf grasses, mostly Canada and Kentucky bluegrass; 0, I, unknown; general east of the Rocky Mountains. The uredia are orange-yellow with numerous peripheral paraphyses. Telia are covered rather permanently with epidermis; spores are dark brown with short pedicels. The wheat stem rust is more important on Merion bluegrass.

Puccinia calcitrapae var. **centaureae** (formerly *Puccinia carthami*). Widely distributed on safflower in Great Plains and California. Spores carried on seed or persisting in soil infect seedlings, which often die.

Puccinia canaliculata. **Rust** on purple nutsedge and yellow nutsedge.

Puccinia carduorum. **Rust** on *Carduss tenniflorus* and *Carduss thoermeri*.

Puccinia caricina (*P. caricis* var. *grossulariata, P. pringsheimia*). 0, I on currant, flowering currant, gooseberry; II, III on *Carex* spp. Common only on

wild species or in neglected gardens. Leaves are thickened, sometimes curled in reddish cluster cup areas; there are enlargements on stems and petioles, red spots on berries. Control by eliminating the sedge host.

Puccinia carthami (see *Puccinia calcitrapae* var. *centaureae*). Widely distributed on safflower in Great Plains and California.

Puccinia claytoniicola. On claytonia, Wyoming.

Puccinia conoclinii. On ageratum, Ohio.

Puccinia coronata. **Crown Rust** of oats; Orange Leaf Rust of Oats. 0, I on buckthorn and rattan vine; II, III on oats and grasses. There are several varieties and many physiological races of this rust, which is as destructive to oats as leaf rust is to wheat. Redtop, meadow fescue, ryegrass, and bluegrass are among the lawn grasses that may show orange or black pustules on leaves.

Puccinia crandallii. 0, I on snowberry, wolfberry, coralberry; II, III on grasses, fescues, bluegrass.

Puccinia cynodontis. On Bermuda grass, New Mexico.

Puccinia cypripedii. On orchids.

Puccinia dioicae (*P. extensicola*) in many varieties. 0, I on aster, goldenrod, erigeron, senecio, lettuce, oenothera, rudbeckia, and helenium; II, III on *Carex* spp.

Puccinia dracunculi (see *Puccinia tanaceti* var. *dracunculina*). On artemisia, Wisconsin to the Pacific Coast.

Puccinia flaveriae (see *Puccinia melampodii*). On *Calendula*.

Puccinia graminis. **Stem Rust** of grains and grasses. 0, I on barberry and mahonia, especially in north central and northeastern states; II, III on wheat and other cereals and wild and cultivated grasses.

This is the classic example of rust, the one used in school textbooks and known through the ages as the major limiting factor of wheat production. Proof of the connection between barberry and wheat in the life cycle was not made until 1864, but long before that farmers had noticed that wheat suffered when barberry plants were near. France in 1660, Connecticut in 1726, and Massachusetts in 1755 enacted laws requiring the destruction of barberry near grain fields.

There are six commonly recognized varieties of stem rust:

Puccinia graminis f. sp. *avenae*– on oats, sweet vernal grass, brome grasses, some fescues.

P. graminis f. sp. *agrostidis*– on redtop and other *Agrostis* spp.

P. graminis f. sp. *graminicola*—on St. Augustine grass.

P. graminis f. sp. *phlei-pratensis*– on timothy and some related grasses.

P. graminis f. sp. *poae*– on Kentucky and other bluegrasses.
P. graminis f. sp. *secalis*– on rye, some wheat, and barley grasses.
P. graminis f. sp. *tritici*, wheat rust – on wheat, barley, rye, and many grasses.
Stem rust occurs wherever wheat is grown, but is most serious in northern states. It is dependent on weather conditions, with epidemics and disastrous losses in certain seasons. The amount depends on the maturity of the crop when rust strikes, but losses may run 25% of expected yield for the nation and much higher for individual states. There are a great many physiological races.

On grains and grasses the first rust appears as long, narrow streaks on stems, leaf sheaths, leaf bases, and distal portions of blades. These streaks are uredial sori, the epidermis being torn back to form a white collar around a dark red powdery mass of one-celled urediospores. Later the same sori turn black as dark, two-celled teliospores replace summer urediospores. Stems may be broken at this stage.

The summer spores appear about 10 days after infection. This stage can be repeated, the spores reinfecting wheat, and, since they are carried by wind from one plant to another, one state to another, even to hundreds of miles, they account for large outbreaks of disease. In Mexico and southern Texas this II stage continues through the winter and causes spring infection without the intervention of barberry. Waves of urediospores coming up from the South may start northern infection.

Normally in the North, spring infection starts on barberry from sporidia (basidiospores) produced on a promycelium put forth by a teliospore wintered on a wheat stem. Two sexes occur in this rust, designated + and – rather than male and female. A young teliospore contains two nuclei, one + and the other –; as the spore matures, these fuse to a single nucleus, which divides twice in the production of the four-celled basidium (promycelium). Each cell produces a sporidium; two of these are + and two –. A sporidium falling on a barberry leaf germinates, sends in an infection thread, and develops a mononucleate (haploid) feeding mycelium and finally a flask-shaped pycnium containing pycniospores, which correspond to the sex of the sporidium starting infection. The pycnia are in reddish lesions on the upper leaf surface. Hyphal threads, receptive hyphae, extend through the mouth of the pycnium. Aided by insects, which are attracted by a sweet nectar, pycniospores (spermatia) of one sex are brought into contact with receptive hyphae of the opposite sex, and sexual union takes place, without which there is no further development of the rust.

The dicaryotic or binucleate mycelium formed from the fertilized hypha grows through the cells of the barberry leaf and masses together on the underside to produce aecia filled with a yellowish waxy layer of aeciospores in cluster-cup formation. These spores, unable to reinfect barberry or mahonia are wind-borne to the cereal or grass host, the subsequent mycelium continuing binucleate until the fusion in the teliospore. New crops of urediospores can be produced every 10 to 14 days.

Control. Resistant varieties are of primary importance, but they are difficult to maintain because the sexual process in rusts allows the continuous development of new strains. More than 200 strains are known, but only a dozen or so are important in any one year. Race 15B is prevalent most years and can attack all varieties of wheat grown in this country. Eradication of the barberry eliminates the alternate host and also the breeding place of new rust varieties. Most barberry and mahonia species are under quarantine, but some have been designated rust-resistant by the U.S. Department of Agriculture and may be shipped interstate under permit.

Puccinia helianthi. **Sunflower Rust**. 0, I, II, III general on sunflower, Jerusalem artichoke, and heliopsis. Numerous brownish pustules in which repeating spores are formed develop on underside of leaves, which may dry and drop.

Puccinia heterospora. III on abutilon, hollyhock, mallow, and malvaviscus.

Puccinia heucherae. III on coral bells, woodland star, saxifrage, bishopscap, and foam-flower.

Puccinia hieracii. 0, I, II, III widespread on endive and hawksbeard. Endive leaves are spotted and blighted with dusty spore pustules. The crop is occasionally lost, but no control has seemed practical.

Puccinia horiana. **White Rust**. III, IV on chrysanthemum; no alternate host known. First reported in England in 1964; became widespread there in 1976. Found in amateur chrysanthemum plantings in New Jersey and Pennsylvania in 1977.

Puccinia iridis. **Iris Rust**. 0, I, II, III on bulbous iris, serious in the Southeast, uncommon in Northwest. Small, oblong to oval, red or dark brown powdery spots, often surrounded by a yellow margin, are present on leaves and stems, which may die prematurely. In inoculation tests with Dutch iris, varieties Early Blue, Gold and Silver, Golden West, Imperator, Lemon Queen, and Texas Gold were resistant.

Puccinia jaceae var. **diffusa**. **Rust** on *Centaurea*.

Puccinia lagenophorae. On English daisy.

Puccinia malvacearum. **Hollyhock Rust**. III general on hollyhock, also on mallow, and lavatera. This rust is so common and destructive it limits the use of hollyhocks as ornamentals. Stems, leaves, bracts may be attacked. There are yellow areas on the upper surface of leaves, orange-red spore pustules on the underside, and elongated lesions on stems. Spore pustules are sometimes grayish from formation of sporidia, but the alternate host is unknown. In severe infections leaves dry and hang down along the stem. The fungus winters in pustules in basal leaves and in old stems.

Control. Cleaning up all infected plant parts in fall and again very early in spring is most important; infection starts early in the season, and once it is under way, it is very difficult to curb with a fungicide.

Puccinia melampodii (formerly *Puccinia flaveriae*). On *Calendula*.

Puccinia melampodii. On *Baccharis*, Texas.

Puccinia menthae. **Spearmint Rust**. 0, I, II, III on spearmint, peppermint, oregano, also horse-mint, mountain-mint, dittany, bee-balm, yerba buena, and germander; especially serious for mint farmers in Middle West and Northwest. In spring and early summer the disease appears as light yellow to brown raised spots on deformed stems and leafstalks, sometimes on main veins; golden to chocolate brown spots appear in late summer and fall. Affected leaves dry, and the yield of oil is reduced. The pathogen has at least 10 races. Dusting with sulfur and early cutting are recommended.

Puccinia nakanishikii. **Rust** on lemon grass.

Puccinia pelargonii-zonalis. **Pelargonium Rust**. The uredinial stage of a rust, presumably this species, was found on geranium in New York and California in 1967. It has now been reported in Pennsylvania and Florida. Brown spore pustules appear on leaves, petioles, and stems; leaves turn yellow and drop. Destroy infected plants.

Puccinia phragmitis. 0, I on rhubarb; II, III on reed grass, sometimes present in California but not serious. Aecia are white, on underside of rhubarb leaves, surrounded by pycnia.

Puccinia poae-nemoralis (Syn. **P. poae-sudeticae**) (see *Puccinia brachypodii* var. *poae-nemoralis*). **Bluegrass Leaf Rust**, **Yellow Leaf Rust**. II, III on turf grasses, mostly Canada and Kentucky bluegrass; 0, I, unknown; general east of the Rocky Mountains.

Puccinia polygoni-amphibii. Rust; II, III, on jointweed.

Puccinia polysora. **Southern Corn Rust**. 0, I, unknown; II, III on corn and grasses. Present in the South, requiring higher temperatures than common

corn rust; not very important. Urediospores are yellow to golden, teliospores chestnut brown, angular; often parasitized by *Darluca filum.*

Puccinia psidii. **Rust** on allspice (*Pimenta dioica*) *Melaleuca quinquenervia*, and *Syzygium jambos*.

Puccinia pygmaea. **Rust** on grasses.

Puccinia recondita (*P. rubigo-vera*). **Leaf Rust** of cereals and grasses, with several varieties:

P. recondita tritici (*P. triticina*). II, III on wheat (but not grasses); 0, I on meadow rue. This rust is worldwide and more serious than stem rust in the southern half of the American wheat belt, sometimes epiphytotic with losses up to 30%. The leaf tissue is progressively destroyed through the season, resulting in a reduced number of kernels, shriveled grain, low weight and protein content. Rust pustules breaking through the epidermis greatly increase transpiration losses. Orange uredial pustules are followed later by gray telial sori, but urediospores are the effective spore form and can survive southern winters. There are many physiological races.

P. recondita agropyri. II, III on wheat grasses and wild ryegrasses; 0, I on clematis, buttercup, columbine, larkspur, and other Ranuculaceae. Common in Rocky Mountain area.

P. recondita agropyrina. Similar to the above but occurring outside mountainous areas.

P. recondita apocrypta. II, III on wheat and wild grasses; 0, I on waterleaf and mertensia.

P. recondita impatientis. II, III on redtop and related grasses; 0, I on touch-me-not.

P. recondita secalis. II, III on rye; 0, I on bugloss (*Lycopsis*).

Puccinia solheimi. On dodocatheon, Wyoming.

Puccinia sorghi. **Corn Rust**. 0, I on oxalis; II, III on corn, sweetcorn, general in northeastern and north central states. Cinnamon brown spore pustules cover both leaf surfaces with black pustules toward autumn. The disease is not often serious enough for control measures.

Puccinia sparganioides (*P. peridermiospora*). **Ash Rust**. 0, I, general on ash east of the Great Plains; II, III on marsh and cord grasses (*Spartina* spp.). Ash twigs and petioles are swollen and leaves distorted. Cluster cups filled with yellow powdery aeciospores are formed in the swellings. In New England, where rust is often severe, the most important infection period on ash is May 15 to June 20, with 6 to 8 hours of damp air necessary. Marsh grasses are infected and reinfected July 20 to August 20.

Puccinia stenotaphricola. On St. Augustine grass, Florida.
Puccinia striiformis (*P. glumarum*). **Stripe Rust** of wheat. II, III on wheat, barley, rye, redtop, orchardgrass, and many other grasses. Uredial stage is yellow, and pustules are formed in streaklike clusters on leaves; telia are in black streaks.
Puccinia substriata. **Rust** on eggplant.
Puccinia taneceti. **Chrysanthemum Rust**. II general; III known only in Japan; 0, I unknown. Small blisters of pinhead size appear on underside of leaves and occasionally on upper surface. The spore mass is dark reddish brown and powdery. The rust is more common in greenhouses than outdoors. Optimum germination is at 60° to 70°F; spores are killed at high temperatures.
Puccinia tanaceti var. **dracunculina** (formerly *Puccinia dracunculi*). On artemisia, Wisconsin to the Pacific Coast.
Puccinia thaliae (*P. cannae*). II, III on edible canna, garden canna,and maranta.

Pucciniastrum

Melampsoraceae. Heteroecious with perennial mycelium, pycnia and aecia on conifers: firs and spruces; pycnia subcuticular, other sori subepidermal; telia may be intraepidermal; aecia and urediospores yellow.

Pucciniastrum americanum. **Late Leaf Rust** of raspberry. 0, I on white spruce; II, III on red raspberry, not black. This rust appears late in the season on Cuthbert and other susceptible varieties, in northern half of the country, most common east of the Mississippi. Fine light yellow powdery masses of spores appear on basal leaves, leaf petioles, shoots, and even fruit.
Pucciniastrum epilobii. **Fuchsia Rust**, the alternate hosts are species of Abies.
Pucciniastrum goeppertianum. **Fir-Huckleberry Rust**, **Blueberry Witches' Broom**. 0, I on firs; III on low and high bush blueberries. The fungus is systemic and perennial in blueberries, producing short swollen twigs in a witches' broom effect, and telia forming a polished red layer around the shoots. Destroy diseased bushes; keep blueberry plantations some distance from firs.
Pucciniastrum hydrangeae. 0, I on eastern and Carolina hemlock; II, III on hydrangea.

Pucciniastrum vaccinii (*P. myrtilli*). **Hemlock Rust**, **Leaf Rust** of blueberry; widespread. 0, I on eastern hemlock; II, III on azalea, blueberry, cranberry, lyonia, menziesia, and rhododendron. This is the most common hemlock rust, but often only a single leaf or twig is infected. Aecia are formed on current-year needles. Blueberries have yellow pustules, on leaves only, with defoliation in mid- or late summer.

Ravenelia

Pucciniaceae. Autoecious, tropical with only a few species in United States. Teliospores more or less muriform, with compound stalks.

Ravenelia dysocarpae (see *Ravenelia fragrans* var. *evernia*). On *Mimosa*, Arizona.
Ravenelia fragrans var. **evernia** (formerly *Ravenelia dysocarpae*). On *Mimosa*, Arizona.
Ravenelia humphreyana. On *Poinciana*, Florida, Texas.
Ravenelia indigoferae. On *Indigofera*, Arizona.

Maravalia (Scopella)

Pucciniaceae. Tropical. Uredia and telia subepidermal. Teliospores one-celled, on pedicel.

Maravalia sapotae (formerly *Scopella sapotae*, Syn. *Uredo sapotae*). On sapodilla in Florida, infecting leaves in winter and early spring.
Scopella sapotae, Syn. **Uredo sapotae** (see *Maravalia sapotae*). On sapodilla in Florida, infecting leaves in winter and early spring.

Sphenospora

Pucciniaceae. Tropical. Telia and peridia subepidermal, then erumpent; teliospores waxy, two-celled, on pedicel.

Sphenospora mera. On bletilla, Florida.

Sphaerophragmium

Pucciniaceae. Teliospores stalked, four- to several-celled, with transverse and horizontal septa; on legumes.

Sphaerophragmium acaciae. On lebbek, Florida.

Tranzschelia

Pucciniaceae. Teliospores two-celled, stalked; uredia with pseudoparaphyses; on Ranunculaceae and *Prunus*.

Tranzschelia discolor (*T. pruni-spinosae* var. *discolor*). **Rust** of stone fruits. **Peach Rust**. 0, I on *Anemone coronaria*; II, III on apricot, peach, plum, prune, almond, and cherry, in late summer. Yellow angular spots appear on leaves with powdery spore pustules on underside, reddish on peach, dark brown on almonds; sometimes with late season defoliation. Peach fruit may have round sunken green spots; twigs may have oval blisters in early spring. Urediospores wintering on sucker shoots can start spring infection without the alternate host. The Drake variety of almond is most susceptible.
Tranzschelia pruni-spinosae var. **typica**. 0, I on anemone, hepatica, thalictrum, and buttercup; II, III on wild species of *Prunus.*

Triphragmium

Pucciniaceae. Teliospores stalked, with three cells forming a triangle, each with a single pore.

Triphragmium ulmariae. 0, I, II, III on meadowsweet.

Uredinopsis

Melampsoraceae. Telia on ferns; teliospores scattered irregularly in mesophyll, rarely in subepidermal crust, typically several-celled; aecia white.

Uredinopsis osmundae. **Fir-Fern Rust**. 0, I on balsam fir, widespread; II, III on *Osmunda* spp.

Uredinopsis phegopteridis. **Fir-Fern Rust**. 0, I on balsam fir; II, III on *Phegopteris dryopteris*.
Uredinopsis pteridis (*U. macrosperma*). **Fir-Fern Rust**. 0, I on various firs; II, III on *Pteridium aquilinum*. Aecia are on 1- to 5-year needles of Pacific silver, white, lowland white, alpine, and noble firs.
Uredinopsis struthiopteridis. **Fir-Fern Rust**. 0, I on balsam, lowland white, alpine, and noble firs; II, III on ostrich fern.

Uredo

Form genus; uredia with or without peridia.

Uredo artocarpi. Breadfruit in Hawaii.
Uredo coccolobae. On sea-grape, Florida.
Uredo ericae (*Pucciniastrum ericae*). On erica, California.
Uredo phoradendri. On mistletoe.

Uromyces

Pucciniaceae. Like *Puccinia* but teliospores with one cell, yellow to dark; aecia when present with a persistent peridium (see Fig. 3.56).

Uromyces appendiculatus. **Bean Rust**. 0, I rare on bean; II, III general on dry beans, widespread but infrequent on lima bean, scarlet runner bean. This is the true bean rust, an old disease reported as far back as 1798 and quite distinct from anthracnose that is sometimes called rust. It is particularly serious and prevalent on Kentucky Wonder pole beans.
Small rust pustules are formed on leaves most frequently, sometimes on stems and pods. The reddish brown sori are most numerous on underside of leaves, with the upper surface yellowing in the same areas. There may be nearly complete defoliation. In late summer in the North, dark telia replace summer spores, but in the South, urediospores survive the winter and start early spring infection. Rust spores are spread by wind and on tools and clothing. Some even cling to supporting poles and can start a fresh outbreak of rust if poles are not disinfested before reuse.
Control. No bean variety is resistant to all of the more than 30 races so far identified. Most snapbeans are highly tolerant of rust; and pole beans White

Kentucky Wonder, U.S. 4 Kentucky Wonder, Potomac, and Rialto are fairly tolerant.

Uromyces appendiculatus var. **appendiculatus** (Syn. *U. phaseoli*). **Rust** on bean.

Uromyces ari-triphylli. On jack-in-the-pulpit; Autoecious, O, I, II, III stages (entire ife cycle) on one host.

Uromyces betae. **Beet Rust**. II, III on beets, and swiss chard, in California, Oregon, occasionally Arizona and New Mexico. Reddish brown pustules may be numerous on foliage in late summer or in wet seasons. Control is seldom attempted for table beets; some sugar beet varieties are resistant. The seed-borne fungus also persists in volunteer plants and debris.

Uromyces ciceris-arietini. **Rust** on chickpea.

Uromyces costaricensis. **Rust** on wild bamboo.

Uromyces dianthi (*U. caryophyllinus*). **Carnation Rust**. 0, I on euphorbia (but not in United States); II, III general on carnation and sweet william, a serious disease under glass. Chocolate brown pustules, varying from 1/16 to 1/4 inch, break out on both sides of leaves and on buds and stems. Leaves curl up, often die; infected plants are stunted.

Control. Use surface watering where possible, avoiding syringing; keep greenhouses properly ventilated; use rust-free cuttings.

Uromyces fabae. **Pea Rust**. 0, I, II, III on pea, peavine, occasionally on broad bean; not very serious.

Uromyces galii-californici. On galium, California.

Uromyces punctatus. **Rust** on *Astragulus* in ID and OR.

Uromyces trifolii, in several varieties. 0, I, II, III on clovers. Pale brown pustules surrounded by torn epidermis, appear on underside of leaves and on petioles and stems.

Uromyces sp. **Rust** on birdsfoot trefoil.

Uropyxis

Pucciniaceae. Autoecious. Teliospores two-celled, on pedicels; uredia with paraphyses.

Uropyxis daleae var. **eysenhardtiae** (formerly *Uropyxis eysenhardtiae*). On *Dalea and Eysenhardtia* in Arizona.

Uropyxis eysenhardtiae (see *Uropyxis daleae* var. *eysenhardtiae*). On *Dalea* and *Eysenhardtia* in Arizona.

SCAB

Diseases characterized by an overgrowth of tissue in a limited area are commonly called scab. The hyperplastic scablike lesions correspond to the necrotic or dead areas of leaf spots and cankers. Diseases called scab caused by *Elsinoë* or its anamorph, *Sphaceloma*, are treated under Spot Anthracnose.

Cladosporium

► Blotch Diseases.

Cladosporium bruneo-atrum. Possible cause of russeting of citrus fruit hitherto attributed solely to citrus mite.

Cladosporium carpophilum (Syn. *Fusicladium carpophilum*), apparently a different strain from peach scab fungus. **Almond Scab**. Water-soaked symptoms on young shoots turn brown; leaves turn black, drop prematurely; circular, olivaceous spots coalesce on fruit.

Cladosporium carpophilum. **Peach Scab**, general on peach, widespread on apricot, nectarine, cherry, and plum. The form on cherry and European plum has been attributed to *Venturia cerasae* (*Cladosporium cerasi*). Small, round, olive black spots appear on infected fruits about 6 weeks after petals have fallen. These are usually on upperside of fruit, and cracking may follow. Twigs show nearly circular yellow-brown blotches with gray or bluish borders; cambium may be killed and twig die. Leaf spots are brown, scattered, with tissue drying and falling out, leaving circular holes.

Control. The brown-rot spray schedule should also control scab, a sulfur spray 4 to 6 weeks after petal fall being especially important. A fungicide can be combined with an insecticide spray for curculio.

Cladosporium caryigenum. **Pecan Scab**, **Leaf Spot**, general on pecan, and hickory. Scab is perhaps the most important limiting factor in pecan production in the Southeast. All varieties are somewhat susceptible, even

those, like Stuart, that have been quite resistant in the past. Crop losses may reach 75 to 95%.

The fungus attacks rapidly growing tissue in leaves, shoots, and nuts; mature growth seems to be immune. On Schley and other highly susceptible varieties, primary infection shows in elongated olive brown lesions on veins and underside of leaves. With secondary infection leaves appear almost black, as a result of coalescing of spots; defoliation follows. On more resistant varieties, such as Moore and Stuart, infection is often delayed until the leaves are nearly mature, and so scab spots are confined to nuts. Nut lesions are small, black, circular, slightly raised at first, then sunken. Spots may be so close together that the entire surface turns black; the nuts drop prematurely or remain attached to shoots indefinitely. Infection is correlated with spring and early summer rainfall, continuous moisture for 6 to 8 hours being required for the spores to germinate and enter the host. First lesions appear in 1 or 2 weeks.

Control. Knock off old shucks and leaf stems before trees leaf out in spring. When they are wet after a rain, a slight jarring of branches will make such diseased material drop. Prune off low limbs for better air circulation. Four protectant sprays are required in Georgia, five in Florida.

Cladosporium cladosporioides f. sp. **pisicola** (formerly *Cladosporium pisicola*). **Pea Scab**, **Black Spot** of pea. Dark spots covered with velvety mold are formed in moist weather on leaves, stems, where black streaks may develop into cankers and pods may be distorted. The fungus is seed-borne, and lives in soil in plant refuse.

Cladosporium coreopsidis. Reported on coreopsis in Wisconsin, causing stunting and suppression of flowering.

Cladosporium cucumerinum. **Cucumber Scab**, general on cucumber in greenhouses, an important transit and storage decay of muskmelon, sometimes serious on late-planted squash. The disease was first noted in New York in 1887. Leaves with water-soaked spots may wilt, stems have slight cankers, but most injury is to the fruit. First symptoms, while cucumbers are still small, are gray, slightly sunken spots, sometimes exuding a gummy substance. They darken with age, and the collapsed tissue forms a pronounced cavity, lined with a dark green velvety layer of greenish mycelium, short conidophores, and dark, one- to two-celled spores. On leaves, these fruiting fascicles are extruded through stomata. The disease becomes epidemic after mid-summer, when night temperatures are cold or with heavy dews and fog.

Control. Resistant cucumber varieties include Maine No. 2, Wisconsin SR 10, SR 6, and Highmoor. A long rotation is advised.
Cladosporium pisicola (see *Cladosporium cladosporioides* f. sp. *pisicola*). **Pea Scab**, **Black Spot** of pea.

Fusarium

► Rots.

Fusarium heterosporum. **Head Scab** of tall fescue.

Spilocaea (Fusicladium)

► Leaf Spots.

Fusicladium dendriticum (see *Spilocaea pomi*). Conidial stage of the apple-scab fungus. ► *Venturia inaequalis*.
Fusicladium eriobotryae (see *Spilocaea pyracanthae*). **Loquat Scab**, widespread on leaves, stems, fruit of loquat.
Fusicladium photinicola (see *Spilocaea photinicola*). **Christmasberry Scab** on *Photinia arbutifolia*.
Fusicladium pyracanthae (see *Spilocaea pyracanthae*). **Pyracantha Scab**, widespread on leaves and fruit.
Fusicladium saliciperdum (Syn. **Venturia chlorospora**) (see *Pollaccia saliciperda*). **Willow Scab**, **Blight**, first noticed on willow in Connecticut in 1927, apparently introduced from Europe.
Pollaccia saliciperda (formerly *Fusicladium saliciperdum* (Syn. *Venturia chlorospora*). **Willow Scab**, **Blight**, first noticed on willow in Connecticut in 1927, apparently introduced from Europe. Repeated defoliation has killed thousands of trees in the Northeast. Young leaves are attacked and often killed in spring, almost within a few hours, and from the leaf blades the fungus enters twigs, kills back young shoots, and causes cankers. Olive green felty spore masses are formed on the long veins on underside of leaves. Overwintering is as dormant mycelium in twigs infected the previous spring. Another fungus, *Physalospora miyabeana*, is found with the scab fungus, and the two together form the disease complex known as willow blight. *Physalospora* usually attacks later in the season than *Fusicladium* and causes cankers on larger stems.

Control. Prune heavily to remove diseased parts. Spray with bordeaux with excess lime.

Spilocaea photinicola (formerly *Fusicladium photinicola*). **Christmasberry Scab** on *Photinia arbutifolia*. Brown velvety spots appear on leaves, flower stalks, and green berries; the berries being disfigured when mature. Prune in winter to remove dead wood and foliage. Spray before blossoming with bordeaux mixture.

Spilocaea pomi (formerly *Fusicladium dendriticum*). Conidial stage of the apple-scab fungus. ► *Venturia inaequalis*.

Spilocaea pyracanthae (formerly *Fusicladium eriobotryae*). **Loquat Scab**, widespread on leaves, stems, fruit of loquat. This is similar to pear and apple scab. Dark velvety spots cause more or less deformation of fruit, but the disease is seldom important.

Spilocaea pyracanthae (formerly *Fusicladium pyracantha*). **Pyracantha Scab**, widespread on leaves and fruit. The unsightly black scabs spoil the appearance of bright berries. The fungus winters in the mycelial state in attached leaves. Frequent spraying with bordeaux mixture controls scab but causes some defoliation.

Spongospora

Plasmodiophoromycetes, Plasmodiophorales

Spores in a hollow sphere with several openings; zoosporangia formed; zoospores anteriorly bi-flagellate; sexual fusion of myxamoebae.

Spongospora subterranea. **Powdery Scab** of potatoes, **Canker**, **Spongy Scab**. Indigenous to South America and introduced into Europe more than a century ago, potato scab was not noticed in North America before 1913, in Maine. Ordinarily not important, it causes economic loss in some seasons.

Slightly raised pimples appear on tubers when they are less than an inch in diameter; they are varying shades of brown on the surface, faintly purple underneath. The epidermis, not growing as fast as the pimple, breaks and curls back over the pustule, which, by this time, is a brown powdery mass of spore balls and decomposed plant tissue. The lesions are often "corked off," but under favorable conditions large, depressed cankers may form. The fungus winters on stored tubers or in soil, remaining viable for many years. In the presence of a potato tuber and enough moisture, each spore in the ball

germinates by swarmspores, which stay grouped together in a plasmodium, dissolving cuticle and killing cells. When the food supply diminishes, the plasmodium again breaks up into spore balls.
Control. Avoid low soggy ground; if such soil must be used, acidify it with sulfur as for common scab.

Streptomyces

► Rots.

Streptomyces acidiscabies. **Acid Scab** on beet, carrot, radish, parsley and turnip.
Streptomyces scabies (Syn. *Actinomyces scabies*). **Common Scab** of potatoes, **Beet Scab**, **Corky Scab**, **Actinomycosis**, general on potatoes, widespread on beets, also reported on carrot, parsnip, radish, rutabaga, and turnip. This disease may have been in America as long as potatoes have been grown, but the causal organism was not described until 1890. Scabby potatoes, by lowering the market grade, mean an annual loss of several million dollars. Chief symptoms are the tuber lesions, starting as minute brown specks and progressing to scabs that are warty or with corky ridges, or are pitted and depressed with the skin cracking open. Such potatoes can be eaten, but have poor customer appeal and are wasteful because of the deep peeling required. On beets, the scabs are similar but more bulging.
The pathogen can be found even in virgin soil. It invades young tubers and may sometimes be seen as a grayish coating on freshly dug potatoes. It is most destructive in soils with pH 5.7 and over, with its activity sharply limited in soils slightly more acid. Although its optimum temperature is 72° to 86°F, the fungus can withstand great extremes of temperature and moisture and can pass through the digestive tract of animals, returning to the field in manure.
Control. Seed tubers have been treated with formalin, but the organism is so prevalent in potato soils that such treatment may have little result. Soils already slightly acid may be further acidified with sulfur. Enough sulfur to acidify highly alkaline soil would be too expensive and too injurious to potatoes. Alkaline materials – time, wood ashes, and manure – should not be applied to potato soil. Somewhat resistant varieties include Menonimee, Ontario, Cayuga, and Seneca.

Venturia

Ascomycetes, Pleosporales, Venturiaceae

Perithecia setose, often only near apex, papillate; paraphyses absent; spores unequally two-celled, olive.

Venturia cerasi. On cherry and European plum, perhaps a strain of the peach scab fungus but not infecting peach.

Venturia inaequalis (Anamorph, *Spilocaea pomi*). **Apple Scab**, **Scurf**, **Black Spot**, general on apple except in far South, widespread on crabapple; reported also on mountain-ash and hawthorn, but probably other species of *Fusicladium* infect these hosts. Scab is the world's top-ranking apple disease and is probably coextensive with the host. In this country it takes a fourth or more of the crop in a favorable scab year, the average national loss running around 8%, or over 10 million bushels. Scab is somewhat less important in the South and in irrigated sections of Washington, but it is important in the humid coastal areas (Fig. 3.58). The pathogen was first described and named by Fries in Sweden in 1819 and was recognized in New York and New Jersey in 1834, apparently having come here with some European imports.

Symptoms. The first symptom of scab on leaves is a dull smoky area that changes to an olive-drab moldy spot, 1/4 inch or more in diameter, without a sharp outline. Sometimes the leaf is raised or domed in the vicinity of the

Figure 3.58 Apple Scab on Leaf and Fruit

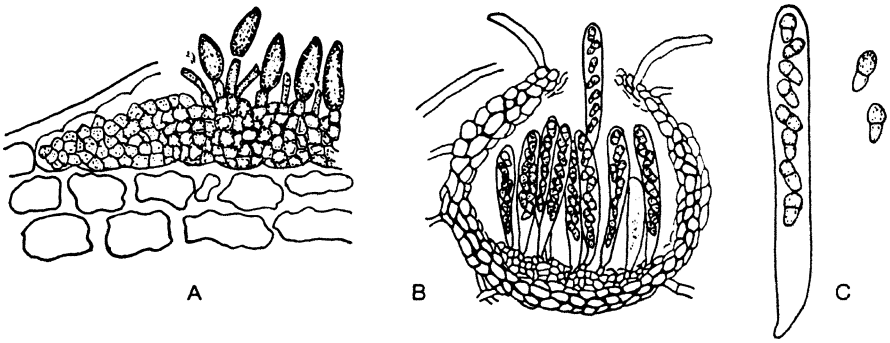

Figure 3.59 *Venturia inaequalis*, the apple-scab fungus. **A** one-celled dark conidia of *Fusicladium* stage; **B** perithecium with two-celled ascospores

spot; sometimes it turns brown and drops prematurely. Similar spots may be formed on blossom pedicel, calyx, and petals, followed by dropping of young fruit. Scabby lesions sometimes appear on twigs, but are less common.

On fruits, spots are small, more or less raised, rounded, dark olive areas (see Fig. 3.58). As they increase in size, the cuticle ruptures to form a white rim around a dark, velvety center, and still later the center may be raised, corky, and tan in color, after dark mycelium and spores have disappeared. Lesions are usually most abundant near calyx end of fruit; if they are too numerous, the fruit splits.

Life History. The fungus winters in dead fallen leaves, producing small, dark, flask-shaped perithecia and, toward spring, asci with eight brown ascospores, unequally two- celled, with the upper cell wider than the lower (Fig. 3.59). The ascospores mature about the time blossoms show pink, and are forcibly expelled during warm spring rains. Each ascus elongates, protrudes its tip through the mouth of the perithecium, and explodes its spore content. When a spore, carried by wind, arrives on a young leaf or bud, it penetrates the cuticle with a germ tube and develops a layer of branching mycelium just under it. The scab spot is evident in about 10 days, when brown conidiopores bearing olive brown, one-celled, somewhat pointed spores appear on the surface. Secondary infection occurs when these conidia are carried to new infection courts.

The expulsion of ascospores proceeds in a series of discharges over a rather long period, up to 3 months, starting in February, on the West Coast, but a shorter period, beginning in April, in New York. Germination and infection take place from 41° to 79°F. Length of wetting period necessary for primary

infection decreases as the temperature rises – 13 to 18 hours of continuous wetting at 43°F and only 4 to 6 at 70°F. Secondary infection from conidia continues all season in rainy periods and even in storage scab may show up on apples infected just before picking.

Control. No varieties are immune to scab. Resistance varies with the season and the part of the country. McIntosh apples are very susceptible; Baldwins are fairly resistant but may scab badly some years. There is more than one strain of the fungus. Nitrogenous fertilizers increase yield of the fruit but also susceptibility to scab.

Protective spraying, having a chemical film on blossom, fruit, or foliage at all times when weather makes infection probable, is the only real answer to scab. This may mean more than a dozen applications in a wet year and a minimum of five any season, a program more suited to the commercial grower than to the amateur. Timing is all-important, and most states have a spray warning service that tells of imminent discharge of ascospores. Any spray schedule must be tailored for the locality, the season, and apple varieties grown. The apple grower gets this specific help from his county agents.

Venturia pyrina (Anamorph, *Fusicladium pyrorum*). **Pear Scab**, general on pear, also on quince, similar to apple scab. The pear species of *Venturia* overwinters in fallen leaves and also in affected twigs; the perithecia mature somewhat later than those of apple scab. Conidia are formed on pear twigs and washed to leaves and fruit.

Pear scab is not serious except on such varieties as Flemish Beauty, Winter Nelis, Seckel, Anjou, Bosc, and Duchess. Bartlett pears are rather resistant.

SCURF

Two diseases, one of sweetpotatoes and one of potatoes, are commonly called scurf.

Monilochaetes

Deuteromycetes, Hyphomycetes

Hyphae and conidiophores dark, spores hyaline, one-celled, oblong-cylindric, in chains.

Monilochaetes infuscans. **Sweetpotato Scurf**. Small, circular, brown or black spots are formed on all underground parts, often forming a uniform patch over the whole potato or a black patch on red-skinned varieties. The skin cracks, and potatoes shrink in storage. The black conidiophores stick up from the surface of the lesions like bristles. The fungus winters on the roots and on decaying vines.
Control. Scurf, formerly present in 50% of New Jersey sweetpotatoes, is now rare because of proper care. Set only healthy sprouts, grown from potatoes bedded in sand that has not grown sweetpotatoes before.

Helminthosporium (Spondylocladium)

Deuteromycetes, Hyphomycetes

Conidiophores dark, straight, septate, the upper cells bearing whorls of conidia; conidia dark with three or more cells.

Helminthosporium solani (formerly *Spondylocladium atrovirens*). **Silver Scurf** of potatoes. **Scab**, **Dry Rot**, present in almost all potato districts but not too important. Light brown lesions become somewhat blistered, giving the skin a marked silvery appearance. The disease is only skin deep, and control measures are seldom used.

Spondylocladium atrovirens (see *Helminthosporium solani*). **Silver Scurf** of potatoes. **Scab**, **Dry Rot**, present in almost all potato districts but not too important.

SLIME MOLDS

Slime molds belong to the Myxomycetes, a group intermediate between bacteria and fungi. Their assimilative phase is a plasmodium, which is transformed into distinct fructifications on a substratum. They are not parasitic and are often found in rotting logs. Sometimes they are a nuisance in lawns, for the plasmodium after ingesting decayed organic matter or microorganisms for food moves up a grass blade for fruiting. Their spores are produced on or in aerial sporangia and are spread by wind. On absorbing water the spore cracks open and the contents escape as a swarmspore, sometimes two, with two flagella. The swarmspore ingests food like an amoeba, divides by fission into a myxamoeba, unites with another to form a zygote, which enlarges, with mitotic division, into a multinucleate plasmodium. There are many species. Two only are listed here, as being common on turf.

Fuligo septica (formerly *Mucilago spongiosa*). Cream to yellow plasmodium forms large grayish white structures, 2 to 6 cm long by 1 to 6 cm wide, that are lobed and branched sporangia filled with a dark mass of purple, spiny spores.

Mucilago spongiosa (see *Fuligo septica*).

Physarum polycephalum. Plasmodium colorless, watery-white or yellow. Fruiting bodies small, gray, sessile, crowded on grass blades, and scattered in groups or rings over an area of several feet. Spores are purple brown in mass. The sporangia develop during humid weather in summer and autumn. Use a stream of water to wash the spore masses off the grass.

SMUTS

Smuts, of the fungus order Ustilaginales, are named for their sooty black spore masses. Like the rusts, they belong to the Basidiomycetes and are all plant parasites, of most economic importance on cereals and grasses, but they differ from rusts in having a less complicated life history and in being able to live part of their lives saprophytically in rich organic matter or in culture media. There are two spore forms. The teliospore, usually called a chlamydospore, is formed by the rounding up of a hyphal cell. In addition to a thin inner endospore wall, it has a thick outer exospore wall, usually dark, smooth or ornamental. Teliospores are formed singly or united into balls. They can be distributed long distances by wind, and spores of some species remain viable for years. Some have to ripen several months before they can germinate.

Occasionally the teliospore puts out a germ tube that penetrates host tissue directly. More often it produces a promycelium that gives rise to sporidia, which can bud to more sporidia. Classically true smuts have been divided into two families on the type of sporidial formation: Ustilaginaceae, with sporidia produced on the sides of a four-celled promycelium, and Tilletiaceae, with sporidia produced at the end of a one- or two-celled promycelium. Fischer, however, points out that there are so many variations that it is preferable to include all species in a single family, Ustilaginaceae, and to differentiate the species on the basis of morphological characters and the host family. This is logical, but we include here the families as they are given in most textbooks and also the false smuts, Graphiolaceae (Ustilaginales), which have an uncertain taxonomic position.

There are three types of infection with smuts, with control measures modified according to type. The mycelium always penetrates the young host tissue directly; it does not enter through stomata.

1. Infection of seedlings as the seed germinates, from spores adhering to the outside of the seed or present in soil; controlled by dusting seed and planting in noninfested soil.

2. Seedling infection by mycelium within the seed as a result of ovary infection from spores germinating on the stigma; controlled by treating seed with hot water.
3. Infection of any actively growing meristematic tissue (roots, shoot, tassels, or young ears) by spores transported by wind from decaying plant material; controlled, partially, by spraying or dusting susceptible plants.

Burrillia

Tilletiaceae. Sori in various host parts, often in leaves, rather permanently embedded. Spore balls with a central sterile mass surrounded by fertile teliospores but no sterile cortex (surface layer). Teliospore hyaline to yellowish, rather firmly united. On water plants.

Burrillia decipiens. **Leaf Smut** of floating heart (*Nymphoides*).

Cintractia

Ustilaginaceae. Sori usually in ovaries, black, more or less agglutinated spore masses with a peridium. Teliospores single, olive to reddish brown, formed from a fertile stroma surrounding a central columella of host tissues. On Cyperaceae and Juncaceae.

Doassansia

Tilletiaceae. Sori usually in leaves; spore balls large and conspicuous, with a sterile layer around fertile cells. Teliospores pale yellowish brown to hyaline, thin walled. Germination often *in situ*. On water plants.

Doassansia epilobii. **Leaf Smut** on epilobium.

Entyloma

Tilletiaceae. Sori generally in leaves forming light spots, giving the name white smut, or slightly raised darker blisters. Teliospores produced singly but often adhering in irregular groups – hyaline to pale green, yellow, or brown. Sporidia formed on the surface give the white powdery appearance.

Entyloma calendulae. Calendula White Smut. Spots are pale yellow, turning brown to black, 1/4 inch in diameter. The smut is common but not very serious in commercial calendula plantings around San Francisco. Plant debris should be cleaned up, perhaps the location changed.
Entyloma compositarum, White Smut of composites, boltonia, calendula, erigeron, eupatorium, gnaphalium, golden-glow, helenium, and prairie coneflower.
Entyloma dactylidis (*E. crastophilum* and *E. irregulare*). Bluegrass Blister Smut, on *Poa* spp., Oregon, Washington, Minnesota, North Dakota. Gray-black, blister areas in leaves from subepidermal masses of chlamydospores. A series of fine dotlike masses of sporidia (conidia), appear scattered in rows along surface of the blisters.
Entyloma dahliae. Dahlia Leaf Smut, a European disease occasionally reported here. It showed up in one location in California where overhead watering was used, but disappeared when the practice was discontinued. Leaves are marked by more or less circular spots, first yellow-green, then brownish and dry. Primary spores germinate in leaves and send projections to the outside, where secondary spores are formed to spread the disease. Late planting seems to increase disease incidence.
Entyloma ellisii. Spinach Smut. An occasional disease with infected leaves pale and worthless. Spores are produced in irregular, marginal necrotic lesions.
Entyloma lineatum. Smut of wild rice.
Entyloma polysporum. Leaf Smut of gaillardia, golden-glow, senecio, sylphium, andsunflower.

Graphiola

Ustilaginales. This family and genus are sometimes included in the smuts, sometimes not. The sori are erumpent, enclosed in a compact black peridium on leaves of palms. The spores are formed in parallel chains, and bud laterally to form two or more sporidia, which become somewhat colored with thickened walls.

Graphiola phoenicis. False Smut of palms, Leaf Spot on queen, canary date, royal and Washington palms and on palmetto. Leaves are yellow-spotted with small black scabs or warts having a dark, horny outer surface and long, flexuous sterile hyphae protruding from an inner membrane containing powdery yellow or light brown spore masses. Seriously infected

leaves may die. The disease occurs on date palm where humidity is continuously high, but is checked in desert areas best suited to date culture. Kustawy variety is less susceptible than some others.
The disease also appears on small ornamental palms in greenhouses and conservatories. Cut out and burn infected leaves or parts.

Mycosyrinx

Ustilaginaceae. Spores united in pairs; sori with a double peridium in swollen pedicels and peduncles. Mostly tropical.

Mycosyrinx osmundae. Inflorescence Smut on osmunda fern.

Neovossia

Tilletiaceae. Sori in ovaries, semi-agglutinated to powdery. Teliospores borne singly, each with a long pedicel appendage, and producing many sporidia.

Neovossia iowensis. On grains, affecting kernels in the dough stage.

Schizonella

Ustilaginaceae. Sori in leaves; short to long striae; black, agglulinated teliospores in pairs, germinating with three- to four-celled promycellium with lateral sporidia. Two species on Cyperaceae.

Sorosporium

Ustilaginaceae. Spores loosely united into balls, readily separable by pressure, in various hosts, more often in reproductive parts. Germination by promycelium and sporidia or germ tube. Mostly on grains.

Sorosporium saponariae. Flower Smut of silene.

Sporisorium

Ustilaginaceae. Sori in various host parts but mostly in inflorescence; granular to powdery, covered at first by a peridium. Teliospores single, formed around a central columel-

la. Germination usually with sporidia. Most species on grains and grasses, sometimes causing severe stunting.

Sphacelotheca cruenta (see *Sporisorium cruentum*). **Loose Kernel Smut** on sorghum, causing smutting and excessive branching.
Sphacelotheca reiliana (see *Sporisorium holci-sorghi*). **Head Smut** of corn, in Pacific states and scattered locations in South.
Sphacelotheca sorghi (see *Sporisorium sorghi*). **Covered Kernel Smut**. Kernels replaced by smut galls
Sporisorium cruentum (formerly *Sphacelotheca cruenta*). **Loose Kernel Smut** on sorghum, causing smutting and excessive branching. Controlled by seed treatment and resistant varieties.
Sporisorium holci-sorghi (formerly *Sphacelotheca reiliana*). **Head Smut** of corn, in Pacific states and scattered locations in South. Galls on tassels and ears breaking into loose dark brown spore masses. Do not plant in a smutted field for 2 years; use certified seed, resistant hybrids.
Sporisorium sorghi (formerly *Sphacelotheca sorghi*). **Covered Kernel Smut**. Kernels replaced by smut galls.

Thecaphora

Ustilaginaceae. Sori in various host parts, mostly inflorescence; powdery or granular. Spores firmly united into balls, with no sterile cells. Chiefly on Leguminosae and Convolvulaceae.

Tilletia

Tilletiaceae. Sori mostly in ovaries, occasionally in vegetative parts of host forming a powdery or semi-agglutinated spore mass, often foetid. On grains and grasses, called bunt; interior of seed a solid mass of spore balls (see Fig. 3.60).

Tilletia buchloëana. **Bunt** of buffalograss.
Tilletia caries. **Dwarf Bunt** of wheat. Plants a fourth or half size of healthy plants.
Tilletia foetida. **Stinking Smut**, **Common Bunt** of Wheat, on wheat and wheat grasses wherever grown, occasionally on rye. A major agricultural disease, especially in Pacific Northwest, this is of historical importance as the first disease controlled by seed disinfection. In 1670 a ship was wrecked

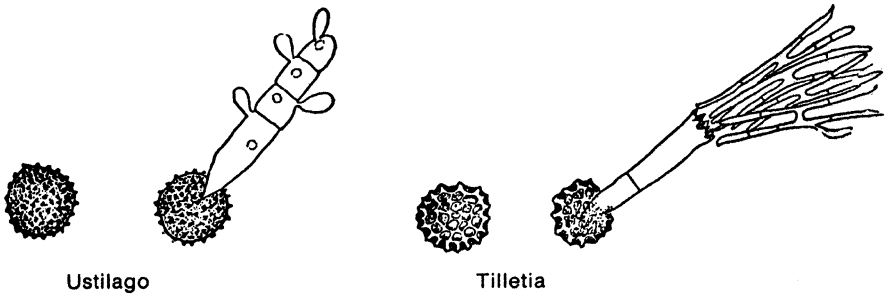

Figure 3.60 Smut Spores. *Ustilago* (left), spiny chlamydospore germinating with promycelium and sporidia formed at sides; *Tilletia* (right), reticulate chlamydospore with long H-shaped sporidia formed at end of promycelium and sometimes forming small secondary sporidia

off the Coast of England, but the cargo of wheat was salvaged, free from bunt because of its salt-water bath. Dark smut balls replace kernels, and there is a fishy odor. Plants are stunted, but not as much as with dwarf bunt. Spore balls are broken in threshing and seed contaminated. Many materials are offered for seed treatment. Seed dealers treat seed for farmers in special machinery at low cost.

Tilletia pallida. **Bunt** on velvet and creeping bent grass, Oregon, Rhode Island. Seeds are filled with black spores, plants stunted. The disease is serious where grass is grown for seed, with up to 80% nonviable seed.

Urocystis

Tilletiaceae. Sori mostly in leaves and stems, blackish; embedded in host tissues. Spore balls permanent, without sterile cortex but sometimes with a layer of hyaline, hyphal fragments. On Liliaceae, Primulaceae.

Tuburcinia trienthalus (see *Urocystis trientalus*). **Leaf and Stem Smut** of starflower.

Urocystis trientalus (formerly *Tuburcinia trientalus*). **Leaf and Stem Smut** of starflower.

Urocystis

Tilletiaceae. Sori usually in leaves, stem sheaths, occasionally in flowers; dark brown to black, powdery to granular. Spore balls with distinct sterile spores on the surface, only a few fertile spores. Sori without peridium.

Urocystis agropyri. **Flag Smut** of wheat, also on wheat grass, red top, and bluegrasses. Symptoms are similar to those of stripe smut.

Urocystis anemones (including *U. hepaticae-trilobae*). **Leaf and Stem Smut** of anemone, hepatica, and trautveteria.

Urocystis carcinodes. **Smut** of aconite, baneberry, clematis, and cimicifuga.

Urocystis colchici (Fischer includes *U. cepulae* in this species). **Leaf Smut** of autumn crocus, camassia, Solomons-seal and false Solomons-seal.

Urocystis gladiolicola. **Gladiolus Smut**. This disease had been intercepted several times at quarantine and appeared once in California fields, in 1950, but apparently is eradicated there. Growers should be on the lookout for corms with low blister swellings, with ridges paralleling veins, bluish black, breaking open to expose dense black spore balls. Seedlings exhibit blistering, shredding, and necrosis of stem and leaf tissues; they die if the disease is severe.

Urocystis kmetiana. **Floral Smut** of field pansy (*Viola bicoler*).

Urocystis magica (*U. colchici*). **Onion Smut**, general on onion, also on leek, shallot, garlic, and chives. This is the most destructive onion disease, found in the Connecticut Valley as early as 1861 and thence spread to all northern onion-growing sections, but more important where onions are grown from seed rather than sets as in most home gardens.

Black elongated blisters or pustules of spores break out on scales or leaves of young plants. Many plants die; others survive and have black or brown smut pustules on the cured bulbs. Plants are stunted but not rotten, although smut may be followed by secondary rot organisms.

The spores can live in soil for years, but infection is possible only in young plants from the second day after seed germination until the seedling is in first leaf, a period of 10 to 15 days. The spore is able to penetrate the onion through root and cotyledon but cannot enter a true leaf. After entrance it spreads through the seedling until it reaches the leaves to form fruiting pustules just below the epidermis. When this ruptures, spores are dropped, to be disseminated by running water and tools, on feet of persons and animals, and on roots of transplanted vegetables. Onion smut is confined to states with cool summers, optimum soil temperature for infection being 72°F.

Urocystis tritici. **Flag Smut** of wheat. Plants are dwarfed with twisted leaf blades; sheaths are marked with grayish-black stripes; diseased tissues dry up and are shredded. Infected plants rarely produce heads.

Ustilago

Ustilaginaceae. Sori in various host parts; spore masses powdery to agglutinated; usually dark brown to black, in some species yellow to purple without a peridium. Spores single, not united in balls (see Fig. 3.60).

Ustilago avenae. **Nigra Loose Smut**, general on barley.
Ustilago avenae (including *U. perennans*). **Black Loose Smut** on oats and some grasses. Individual flowers in panicle are largely replaced by a spore mass. The young seedling is diseased from the seed, and the fungus grows systemically in the plant.
Ustilago buchloes. **Stripe Smut** on grass.
Ustilago bullata. **Head Smut** on many grasses.
Ustilago esculenta. **Smut** on wild rice.
Ustilago heufleri. **Erythronium Smut**. Large dusty pustules lead to cracking and dying of leaves of dogtooth violet.
Ustilago hordei. **Covered Smut** of barley. Heads are converted into hard, black, smutted masses, enclosed within thin membranes.
Ustilago kolleri. **Covered Smut** of oats. Spore balls remain intact within glumes until threshing, when spores are distributed over surface of seed, ready to infect young seedlings.
Ustilago maydis (*U. segetum*). **Corn Smut**, **Boil Smut**, general on corn but most destructive to sweet corn. The average annual loss is 3 to 5% but it can be 100% in any one field. The fungus was described in Europe in 1754 and not reported here before 1822, but it may be native along with its host. There are many physiological races, and smut resistance is likely to be correlated with lack of vigor, so that it has been hard to breed desirable resistant varieties.
Any plant parts aboveground may be attacked – stalks, prop roots, leaves, tassels, husks, and ears (see Fig. 3.61). Large boils are formed, at first covered with a greenish white membrane, said to be good eating when boiled or fried. Later the membrane breaks and releases myriads of dark chlamydospores. The plant is often distorted. Infections are local; each boil is formed where a spore lands, and there is no systemic growth through the plant. The fungus is not seed-borne, and germinating seedlings are not affected. Chlamydospores winter in soil, corn debris, and manure. They produce sporidia, which may bud to form secondary sporidia, and these are carried by wind and other agencies to corn plants, which are 1 to 3 feet high. Mycelium from

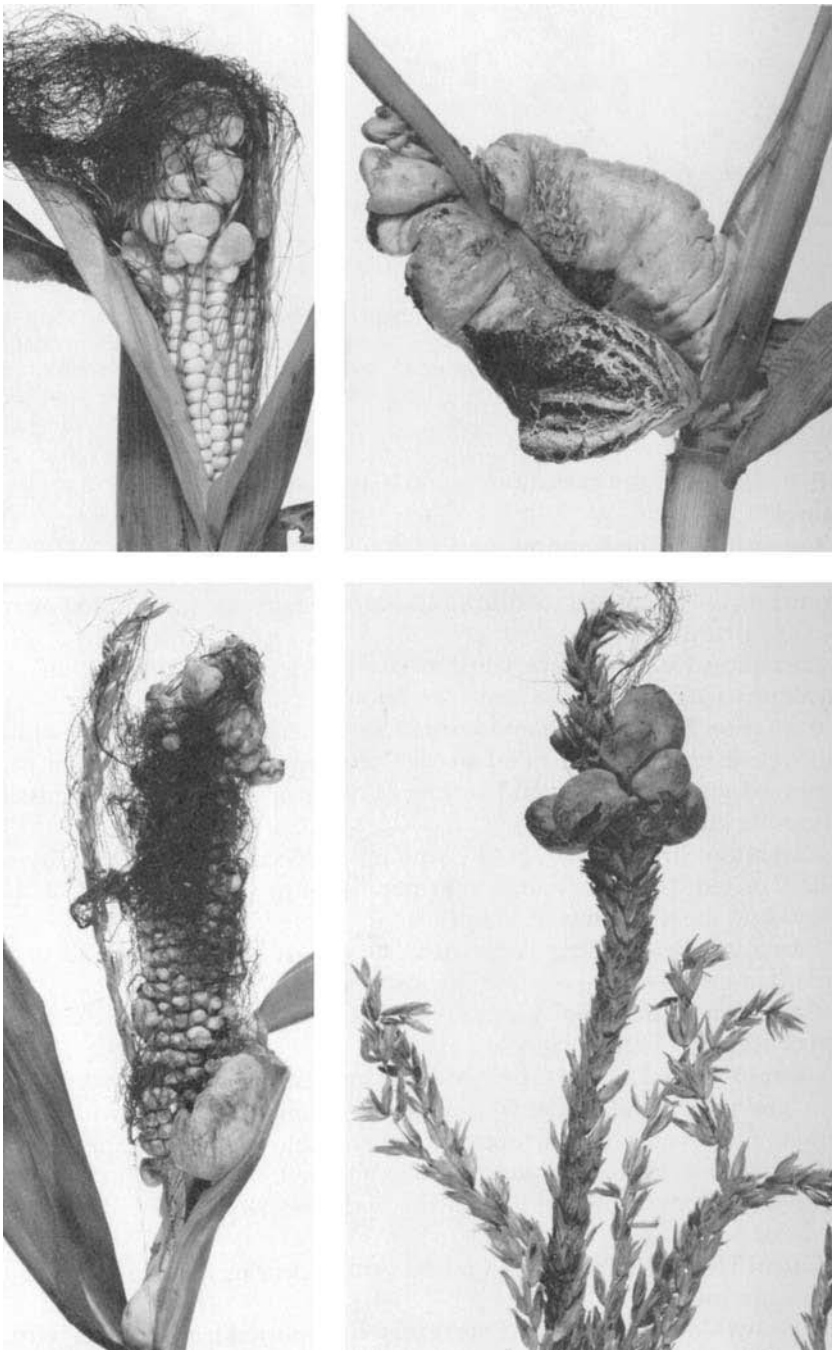

Figure 3.61 Corn Smut

spores of two sexes is needed for active development. Spores formed in the first boils provide inoculum for secondary infection of ears.

Corn smut thrives in warm weather, optimum temperature for spore germination being 80° to 92°F. Heaviest infection occurs when scant rainfall in early stages of growth is followed by moderate rainfall as corn approaches maturity. Vigorous plants are most susceptible, but may escape the most serious effects because of their rapid growth. Spores retain viability 5 to 7 years. They remain viable in passage through an animal into manure, but are killed by the acids in silage.

Control. Seed treatment is not effective. Some hybrid varieties are rather resistant. Most reliance in home gardens should be placed on cleanliness, cutting off and burning all smutted parts before the boils break open to release spores.

Ustilago mulfordiana. **Fescue Smut** on fescue grasses.

Ustilago tritici. **Nuda Loose Smut**. Normal heads replaced by black powdery masses.

Ustilago striiformis. **Stripe Smut**, general on grasses – wheatgrasses, redtop, bentgrasses, fescues, ryegrass, and bluegrass; does not occur on cereals. Long dark narrow striations develop in leaves; as the sori mature, spores are freed, and the blade splits into ribbons. Plants are systemically infected, make poor growth, and inflorescences are stunted or absent. Perennial mycelium may overwinter in the plant.

Ustilago violacea. **Anther Smut** of carnation, dianthus, lychnis, and silene. Infected plants grow slowly, produce many weak axillary shoots; stem internodes are shortened; flower buds are short and squatty; calyxes tend to split; flowers are sprinkled with black sooty dust from the anthers, whose pollen grains are replaced by smut spores. The fungus enters through flowers or injured surfaces and grows systemically. Spores are spread on cuttings. Control by roguing diseased plants before flowering. Do not take cuttings from plants with grassy or bushy habit.

SNOWMOLD

Northern lawns and turf of golf greens often show round light patches as the snow melts in early spring. Such a disease is called snow mold and may be due to one of several fungi, sometimes to two appearing together.

Microdochium (Fusarium)

► Rots.

Fusarium nivale, Teleomorph, **Monographella nivales**). (see *Microdochium nivale*). Pink Snowmold, Fusarium Patch, most important on bentgrass on golf courses but infecting other turf grasses and winter wheat and winter rye.

Microdochium nivale (formerly *Fusarium nivale*, Teleomorph, *Monographella nivales*). Pink Snowmold, Fusarium Patch, most important on bentgrass on golf courses but infecting other turf grasses and winter wheat and winter rye. Irregularly circular patches, from 1 to 2 inches to a foot or more, appear as snow is melting. They are whitish gray, often with a pinkish tinge, and several patches may run together to cover large areas. Individual plants have a bleached appearance, feel slimy when wet. Spores are formed in salmon-pink sporodochia over stomata in leaves. They are sickle-shaped, one- to three-septate. Perithecia are produced on the luxuriant white mycelial mat.

Abundant moisture in the fall, snow falling on unfrozen ground, deep snow, and a prolonged, cold wet spring are predisposing factors, but the presence of snow is not a requisite for the disease. Severity is increased by applying fertilizer in late autumn and an excess of organic matter in the soil. Reports differ as to susceptibility, but Colonial, Washington and Metropolitan bentgrasses appear to be more resistant then Seaside bent.

Sclerotium

► Blights.

Sclerotium rhizodes. **Frost Scorch**, **String of Pearls**, in northern states. Not exactly a snowmold but appearing in early spring with bleached, withered leaves covered with rows of tiny sclerotia. Collect clippings when mowing diseased areas to remove sclerotia on leaf tips.

Typhula

Basidiomycetes, Aphyllophorales

Fruit body erect, simple, like a little club, on a long stipe from a sclerotium; basidia with four sterigmata and simple, hyaline spores.

Typhula incarnata. **Snowmold** of turf and lawn grasses, **Typhula Blight**, common in eastern United States. As the snow disappears in spring, a felty white mycelial mat is seen over grass and adjacent soil. Plants wither and turn light brown or tan in roughly circular patches, very conspicuous against the green of the rest of the lawn. The chief diagnostic character is the presence of very small, tawny to hazel brown spherical sclerotia in large numbers over affected parts. These can be made to fruit in the laboratory into rose-colored sporophores up to 1 inch tall.

Control. The disease gradually disappears as moisture decreases and temperature and sunlight increase; so control seldom seems necessary. Six weeks after striking cases of snowmold, lawns are often uniformly green and show little sign of having been affected. Phosphate fertilizers are said to decrease injury from *Typhula*.

Typhula idahoensis. **Snowmold** on wheat and grasses in Idaho and Montana. Sclerotia are chestnut brown, sporophores fawn to wood brown, less than 1/2 inch high.

SOOTY MOLD

Sooty mold is a black coating on surface of leaves or fruit composed of a weft of dark mycelial threads. As here used, the term applies to saprophytic fungi that live on insect honeydew and harm plants only indirectly. See ►Black Mildew for the true parasites with dark mycelium and spores giving a sooty appearance to foliage.

Capnodium

Ascomycetes, Capnodiales

Mycelium superficial, dark; spores muriform, in perithecium-like conceptacles at tips of branches of a carbonaceous stroma; associated with insect secretion on living plants.

Capnodium citri. Sooty Mold on citrus, on honeydew secreted by scale insects, aphids, whiteflies, especially abundant following whiteflies in Florida, black scale in California. A black velvety membranous coating is formed over leaves, twigs, and fruit. If honeydew is slight, the coating appears in spots; but if the insect secretion is abundant, the entire surface may be covered by a dense continuous membrane resembling black tissue paper. With age, under dry conditions it may be blown off in fragments. The black membrane is made up of hyphae that are individually olive green to deep brown, with wide short cells. Branches may crisscross or be cemented together. There are several spore forms: simple conidia that are cut off from upright hyphae, others formed in small, black pycnidia, stylospores in very long flask-shaped conceptacles, and muriform brown ascospores in perithecia.
Although sooty molds do not obtain food from the plant, the black membrane interferes greatly with photosynthesis and food manufacture. Affected fruit is smaller, with coloring retarded; it is more likely to decay than normal fruit. *Control* is directed against the insects, either by spraying with insecticides or by using entomogenous fungi and insect parasites. Oil sprays kill the insects and help to clean the trees of the sooty covering.

Capnodium elongatum. **Sooty Mold** of tulip-tree, oleander, holly-osmanthus, and others. Foliage of tulip-trees very frequently has a black coating, often on honeydew secreted by the tulip-tree aphid, sometimes following attacks of tulip-tree scale. A dormant oil spray controls the latter.

Capnodium spp. **Sooty Mold** on gardenia, fig, crape-myrtle, azaleas, and many other plants. Gardenias are especially subject to sooty mold following whiteflies, crape-myrtle after aphids, azaleas after mealybugs and magnolias after scales. A summer oil spray helps to control the insects and loosens the black coating so that it is more readily washed off.

Very often rhododendrons and other broad-leaved evergreens growing inside the branch spread of tulip and other trees afflicted with aphids and scales are covered with sooty mold growing in the honeydew dropped down on foliage from the tree overhead.

Fumago

Deuteromycetes, Hyphomycetes

Mycelium dark, creeping over surface of leaves; conidiophores dark, variable, bearing conidia terminally or laterally; conidia variable, dark, muriform, frequently in chains; saprophytic on honeydew; probably conidial stage of *Capnodium*.

Fumago vagans. A heavy black moldlike growth on leaves of linden and many other ornamental trees and shrubs, also on house plants in honeydew from aphids, mealybugs and scale insects.

Scorias

Ascomycetes, Capnodiales

Mycelium with parallel walls, forming a thick spongy mass; perithecium long-stalked, round; spores four-celled.

Scorias spongiosa. **Sooty Mold**. Often on trees – alder, beech, pine, etc.

SPOT ANTHRACNOSE

Diseases caused by species of *Elsinoë* anamorph state *Sphaceloma*, are characterized by some overgrowth of tissue. When this hyperplasia is pronounced, the disease is usually called scab; when the overgrowth is scarcely noticeable (merely a slightly raised border around a necrotic center), the disease has been commonly known as anthracnose. Recently, the term spot anthracnose was introduced to differentiate a *Sphaceloma* malady from anthracnoses caused by fungi with slime spores (*Colletotrichum, Glomerella*) and from the *Venturia* type of scab diseases. Consequently, all spot anthracnose diseases are included in this section, but with the common designation, scab or anthracnose, also listed.

Elsinoë

Ascomycetes, Myriangiales, Elsinoaceae

Asci are borne singly, at different levels, in an effused stroma, having a gelatinous interior and crustose rind, under or within the epidermis, which ruptures to expose the asci. The anamorph state is a *Sphaceloma*.

Elsinoë ampelina. **Grape Anthracnose**, **Bird's Eye Rot**, widespread on grape. Small sunken spots with dark margins and light centers occur on fruit, young shoots, tendrils, petioles, and leaf veins. Leaves may be distorted and ragged from diseased portions dropping out. Outbreaks are sporadic in eastern states. Varieties Catawba, Campbell Early, Diamond, Norton, and Salem are quite susceptible; Concord, Delaware Moore Early, and Niagara are resistant. The fungus winters on canes.

Control. Apply a dormant lime-sulfur spray and four or five sprays of bordeaux mixture: when new shoots are 7 to 8 inches long; just after bloom; 7 to 10 days later; and when berries are half grown.

Elsinoë cinnamomi. **Camphor-Tree Scab**. Inconspicuous brown leaf spots, sometimes dropping out; elongated raised lesions on veins, petioles, and stems. Reported from South Carolina.

Elsinoë corni. **Dogwood Spot Anthracnose**, a serious threat to flowering dogwood from Delaware to Florida, also reported from Louisiana. Infected buds do not open, or they produce stunted, malformed "flowers," marked with numerous small, circular to elongated spots with light tan centers, purple to brown borders, up to 50 on a bract. Leaf spots are 1 to 2 mm, slightly raised at the margin, purple paling to yellow-gray at centers, which may be broken in a shot-hole effect. There may be 100 spots on a leaf, scattered or concentrated at tip, margin, or midrib. Spots on petioles, fruit clusters, and stems are similar to leaf spots.

Elsinoë diospyri. **Spot Anthracnose** on leaves of native persimmon, reported from Florida, 1955.

Elsinoë euonymi-japonici. **Spot Anthracnose** on evergreen euonymus, Florida. Small, roundish spots, mostly on upper surface of leaves, brown with raised, orange-cinnamon margin; stem cankers circular to elliptical, wrinkled or fissured, grayish white with raised orange margins.

Elsinoë fawcettii. **Sour Orange Scab**, **Citrus Scab**, **Verrucosis** on citrus fruits, except rare on sweet orange. Lemons, sour orange, King orange, bitter orange, and calamondin are very susceptible; Mandarin and Satsuma oranges, tangerines, and all grapefruit except Royal and Triumph are moderately susceptible. Climatic conditions play a part. Grapefruit and lemons in the Rio Grande Valley are less susceptible than in Florida, but Satsumas in Alabama are more susceptible than those in Florida. Known in the Orient since ancient times, scab is believed to have come to Florida on Satsumas from Japan. It was first recorded there in 1885; the fungus was identified as a *Sphaceloma* in 1925.

Tender growth is most readily infected, and the disease is most important on young trees. On leaves, minute, semitranslucent spots change to raised excrescences with corky crests, pale yellow to pinkish, then dull olive drab with a conical depression opposite the crust. Foliage may be wrinkled or stunted. Fruits have slightly raised scabs or are warty with corky crests, which may grow together into large irregular patches. Scabs on grapefruit may flake off as the fruit matures, with the area remaining green.

Spores are spread by wind, rain, dew-drip, possibly by insects. The young fruit of grapefruit is very susceptible right after petal fall, but becomes progressively resistant and is practically immune when it reaches 3/4 inch in diameter. Temperature range for severe infection is from 59° to 73°F. Excessive nitrogen increases scab. The pathogen winters on infected leaves, sometimes fruits.

Control. Apply a neutral copper spray or bordeaux mixture just before growth starts in spring. A second copper spray, just after flowers shed, controls melanose as well as scab.

Elsinoë ilicis. Chinese Holly Spot Anthracnose. Numerous black spots, 1 to 2 mm, coalesce to large black patches on upperside of leaf mostly the apical half, with distortion. Shoots and berries have brown to gray lesions with slightly raised margins.

Elsinoë jasminae. Jasmine Scab. Reported from Florida. Spots numerous, round or irregular, up to 2 mm.

Elsinoë ledi. Ledum Spot Anthracnose, widespread on ledum, Labrador tea, and salal in Northwest, leucothoë in Florida. Leaf spots are grayish white with red-brown borders and purple margins. The disease is not serious.

Elsinoë lepagei. Scab on sapodilla and canistel in Florida (found on young nursery stock in cans). Small, raised spots, gray at center.

Elsinoë leucospila. Camellia Scab, also recorded on ternstroemia in Florida. Some corky excrescences on camellia foliage are due to this pathogen, others to moisture relations.

Elsinoë magnoliae. Magnolia Scab on *Magnolia grandiflora* from Georgia to Louisiana. Spots are circular to angular, with black papillae in centers, on upper leaf surface along midrib, margin, or tip. Infected leaves may drop.

Elsinoë mangiferae. Mango Scab. Spots usually originate on underside of young mango leaves but become visible above. They are circular to angular, dark brown to black with olive buff centers. Spots on mature leaves are larger, slightly raised with narrow brown margins and dirty white centers. Stems have irregular grayish blotches; fruit, gray to brown spots with dark margins.

Elsinoë mattirolianum. Spot Anthracnose on madrona and strawberry tree (*Arbutus* spp.) in California.

Elsinoë parthenocissi. Virginia Creeper Soft Anthracnose. Leaf spots are few to numerous, circular, scattered or along midribs and veins; they have buff centers with narrow brown margins; fruit spots are grayish white; lesions on petioles are somewhat raised. Also reported from pepper-vine.

Elsinoë phaseoli. Lima Bean Scab. First United States report from North Carolina probably from imported seed. Lesions on pods, stems, and leaves.

Elsinoë piri. Pome Fruit Spot Anthracnose on pear, apple, and quince in moist sections of western Washington and Oregon, more prevalent in home gardens than commercial orchards. Fruit spots are small, up to 2 mm, red or reddish purple with pale centers, upwards of 100 on an apple.

Elsinoë quercicola. Spot Anthracnose on water oak, Florida.

Elsinoë quercus-falcatae. **Spot Anthracnose** on southern red oak, Georgia, South Carolina. Blackish brown leaf spots are few to abundant, scattered over upper surface.

Elsinoë randii. **Pecan Anthracnose**, **Nursery Blight** on pecans in the Southeast, an important nursery disease, limiting factor in production of budded pecans in wet seasons. Small reddish lesions develop on both leaf surfaces, those on the upper surface later turning ash gray. Diseased tissues become brittle and fall out, leaving ragged margins and perforations. Spray trees with bordeaux mixture when first leaves are half grown; follow with three sprays of bordeaux at 3- to 4-week intervals.

Elsinoë rosarum. **Rose Anthracnose**, widespread on rose, collected on wild roses as early as 1898, in most areas more important on climbing roses than on hybrid teas. Leaf spots are scattered or grouped, sometimes running together, usually circular, up to 1/4 inch. Young spots are red, varying brown or dark purple on upper leaf surface, showing up to 2 to 6 days after inoculation but not visible on under surface for 2 to 4 weeks, then dull reddish brown to pale purple. On aging, the center of the spot turns ashen white, with a dark red margin. Leaves may turn yellow or reddish in area of spots, may have slits or perforations as the centers fall out.

Cane spots are circular to elongated, raised, brown or purple, with depressed light centers and acervuli in barely visible dark masses. The fungus winters in cane spots; spores are produced and spread only in rainy periods. A single leaf lesion may produce 10,000 spores within an hour after wetting and will continue production as long as the rain lasts.

Control. Where possible, prune out infected canes in spring. Keep foliage protected as for blackspot. Sulfur and copper compounds are effective.

Elsinoë solidaginis. **Goldenrod Scab** in Florida, South Carolina, and Georgia. New growth is affected as it develops. Lesions formed on midrib, veins, petioles, and leaf blades are raised on one surface, sunken on the other, with white to gray centers and brown borders.

Elsinoë tiliae. **Linden Spot Anthracnose** reported from Nova Scotia and Virginia. Gray spots with black margins are numerous on leave blades and petioles.

Elsinoë veneta. **Bramble Anthracnose**, general on blackberry, dewberry, raspberry, being most common on black raspberry. Circular, reddish brown sunken spots with purple margins and light gray centers, up to 3/8 inch in diameter, appear on young shoots. On older canes these grow together into large cankers. Similar spots, not always with purple margins, are formed on

fruit, leaf, and flower stalks. Leaf spots are first yellowish, then with a red margin around a light center, which may drop out. Leaves may drop prematurely; fruit may dry up as a result of loss of water from infected canes. Primary spring infection comes from ascospores produced in old lesions on canes; secondary spread is by conidia.

Control. Cut old canes or "handles" from black raspberries after setting; remove and burn old fruiting canes after harvest. In some cases the single late dormant spray has controlled anthracnose without later sprays; in others three foliage sprays have been effective without a dormant spray. Black raspberry Quillen is quite resistant.

Sphaceloma

Deuteromycetes, Coelomycetes

Acervuli disc- or cushion-shaped, waxy; conidiophores simple, closely grouped or compacted, arising from a stromalike base; spores one-celled, hyaline, ovoid or oblong. Teleomorph state where known is *Elsinoë*.

Sphaceloma araliae. **Aralia Scab** on Hercules club (*Aralia spinosa*), Maryland and Missouri.

Sphaceloma cercocarpi. **Spot Anthracnose** of birch-leaf mahogany, in California. Leaf spots are nearly circular, up to 3 mm across, with pale centers and slightly elevated purple margins.

Sphaceloma hederae. **English Ivy Scab**. Leaf spots are raised with red-brown margins, pale depressed centers, often numerous.

Sphaceloma lippiae. **Lippia Spot Anthracnose** on fog-fruit. Closely resembling mint anthracnose and found in same fields in Indiana, also reported from Florida. Numerous spots on leaves and stems are scattered or grouped and nearly confluent; centers are depressed, buff-colored, with purple margins.

Sphaceloma menthae. **Mint Anthracnose**, **Leopard Spot Disease**. Circular, oval or irregular spots on leaves, stems, and rootstocks are black with white centers, up to 5 mm. Formerly serious, this disease is now controlled in commercial mint fields by fall plowing, covering plants deeply.

Sphaceloma morindae. **Morinda Scab**. Buff-colored spots on leaves, stems, and petioles, Florida.

Sphaceloma murrayi. **Gray Scab** of willow. Leaf spots are round, irregular, somewhat raised, grayish white with narrow, dark brown margins, often confluent, sometimes fragmenting; long narrow patches along veins.

Sphaceloma oleandri. Oleander Scab. Leaf spots spherical to irregular, densely grouped over entire surface, whitish with brownish black margin, slightly elevated, 1 to 4 mm.

Sphaceloma perseae. Avocado Scab, one of the most important avocado diseases in Florida, some years with nearly 100% infection; also occurring in Texas. Leaf lesions are mostly on upper surface, very small red spots with a dark olive conidial growth. Fruit lesions are corky, raised, brownish, oval, but often coalescing giving a russeted appearance; sometimes cracking to allow entrance of fruit-rotting fungi. Avoid highly susceptible varieties like Lulu. Spray with bordeaux mixture as for blotch.

Sphaceloma poinsettiae. Poinsettia Scab. Light raised lesions on stems, veins, and midribs, pale buff at center with purple to nearly black margins.

Sphaceloma psidii. Guava Scab, reported in feijoa in Florida.

Sphaceloma punicae. Pomegranate Spot Anthracnose. Very small purple spots with paler centers on both leaf surfaces.

Sphaceloma ribis. Gooseberry Scab, Washington. Leaf spots numerous, very small, raised, and grayish.

Sphaceloma spondiadis. Mombin Scab. On purple mombin (*Spondias*) Florida.

Sphaceloma symphoricarpi. Snowberry Anthracnose, widespread on snowberry, impairing beauty of ornamental plants, first described from New York in 1910; also on coralberry. Leaf spots appear in early spring, minute, dark purple to black, aging with dirty gray centers, coalescing into large areas subject to cracking. Leaves may be misshapen from early marginal infections. Spotting is inconspicuous in flowers but pronounced on berries, with purple areas becoming sunken and pinkish. Secondary infection by an *Alternaria* shrivels fruit into brown mummies. A dormant lime-sulfur spray followed by foliage sprays may help.

Sphaceloma viburni. Snowball Spot Anthracnose.

Sphaceloma violae. Violet Scab, Pansy Scab, widespread on violet and pansy from Connecticut to Louisiana and Texas, a limiting factor in maintaining violet collections. Reddish spots with white centers change to irregular to elongated raised scabs on leaves and stems, often with much distortion. Remove and burn old leaves.

Sphaceloma spp. Undetermined species have been reported on *Bignonia*, catalpa, camellia, and sambucus, in Louisiana, on buttonwood in Florida, rhododendron in Washington.

VIRUS, VIROID, PHYTOPLASMA – PATHOGENS AND DISEASES

For many years the classification of plant viruses was in a state of chaos. Fortunately recent biochemical and molecular investigations on organization and structure of genome as well as on structural and nonstructural viral proteins provided enough data to create a definition of species. A virus species is a polythetical class of viruses consisting of replicating lineage and occupying a particular ecological niche. This indicated that viruses and biological entities that possess genes, replicate, interact with hosts and are exposed to selection pressure, thus specialize and evolve. Guidelines provided in the Sixth and Seventh Reports of the International Committee or the Taxonomy of Viruses are partly followed, especially by use of a virus species name or vernacular name for the not fully described viruses. Following are virus species (including viroids and phytoplasmas) and virus diseases in alphabetical order by common names.

Abelia Latent Tymovirus

Symptomless on Abelia; occurs in Eastern USA.

Abutilon Infectious Variegation; Abutilon Mosaic Bigeminivirus

A single variegated seedling found among green plants imported into England from the West Indies in 1868 was propagated vegetatively as an ornamental variety. The bright yellow mottling on green leaves tends to disappear in subdued light. Transmission is by grafting, occasionally by seed, and, in native Brazil, by whitefly *Bemisia tabaci*. Plants may recover if variegated leaves are persistently removed but may be reinfected.

Albutilon Yellows Closterovirus

Transmitted by Triaulerodes abutilonea. Infected plants are chlorotic.

Alligatorweed Stunting Closterovirus

Occurs in North America region and Florida.

Alfalfa Mosaic Alfamovirus

Potato, Celery Calico; Bean Yellow Dot. Various strains of the alfalfa virus are transmitted by cotton, pea, and other aphids to bean, clovers, pea, cucumber, potato, tomato, zinnia, tumbleweed, poison hemlock, wild carrot, Japanese pachysandra, and other hosts. Calico is a minor potato disease in California and Idaho. Leaf spots are irregular, brilliant yellow to gray; yield may be reduced. Celery has a conspicuous yellow-green mosaic; bean has small, necrotic lesions.

Almond Bud Failure

Virus on Drake almond, in California, is transmissible by grafting. Limbs have many branches, some dead at the end; leaves are darker green, more upright, retained longer than normal; fruits few, often misshapen.

Almond Calico

On almonds in California, graft transmissible. Chlorotic blotches in leaves.

Alstroemeria Mosaic Potyvirus and Alstromeria Streak Potyvirus

Both viruses are transmitted by aphids in a non-persistent manner.

Alternanthera Mosaic Potexvirus

Found in Florida, Maryland, and Pennsylvania on skullcap, firecracker plant and moss rose.

Apple Chlorotic Leaf Spot Trichovirus

Originally considered as a closterovirus but now is the type species of Trichovirus genus.

Apple Green Mottle

On Duchess variety in New York. Fruit with discolored rings, of little value.

Apple Mosaic Ilarvirus

Occurring naturally only on apples; no insect vector known; transmitted by budding. Small irregular cream to yellow leaf spots coalesce to large chlorotic areas, with or without vein-banding. Three strains cause severe mosaic, veinbanding mosaic and mild mosaic. There is no marked reduction in yield. Hosts other than members of Rosaceae family include filbert, hop, birch, and horse chestnut.

Apple Stem Grooving Capillovirus

First reported in Viriginia Crab. The main symptoms are stem grooves and abnormal graft union.

Tulare Apple Mosaic Ilarvirus

Reported from California; has a wider host range than apple mosaic.

Apple, Dapple

Fruit with circular islands or patches remaining green; on trees with Virginia crab or Robusta V bodystock; first noted in New Hampshire.

Apple Stem-Pitting

Wood-pitting in Virginia Crab bodystock, sometimes followed by bark cracks, dwarfing, early fruit production.

Apricot Gummosis

First noted in Washington in 1947; transmitted by budding. Profuse gumming on branches and trunks, necrosis and dieback of new shoots; dead, punky areas in fruit.

Apricot Ring Pox

In California and Colorado. Irregular ring spots with marked vein clearing in some varieties, chlorotic mottling in others; dead tissue may fall out leaving shot holes. Fruit bumpy or with reddish brown necrotic spots extending into flesh.

Arabis Mosaic Nepovirus

It is one of the viruses that causes lilac yellow ring symptoms. Occurred on many genera of ornamental, vegetable and orchard plants. Transmitted by nematodes. This virus causes foliar blanching on hosta.

Artichoke (Globe) Curly Dwarf Potexvirus

In California on artichoke, cardoon, and zinnia, milk thistle. Leaves curled, plants dwarfed, killed.

Artichoke Latent Potyvirus

Symptoms on *Cynara* spp. are none or stunting and yellow flecking of plants.

Ash Ring Spot = Arabis Mosaic Nepovirus

On white ash, New York. Chlorotic green and reddish spots, rings, line patterns; stunting; dieback.

Ash Witches' Broom

Reported from Louisiana on Arizona ash. Yellowish leaves, a fourth to a third normal size; multiple, spindly shoots.

Asparagus 1 Potyvirus

Symptomless on *Asparagus officinalis*.

Asparagus 2 Ilarvirus

Caused stunting and decline on *Asparagus officinalis* plants. Virus is transmitted by pollen to the seed and to the pollinated plant.

Aster Chlorotic Stunt Carlavirus

Reported in Aster novae-angliae in Ontario, Canada.

Aster Ring Spot

In Florida on China aster, pepper, pansy, and other plants. Yellow ring, line, and oakleaf patterns. A strain of Tobacco Rattle Tobravirus.

Avocado Sun Blotch Viroid

There are long, narrow, shallow, longitudinal grooves, buff-colored on stems, whitish on green fruit, reddish purple on purple fruit. Shoots may be twisted and abnormal. Transmitted through seeds.

Avocado 3 Alphacryptovirus

Transmitted only by seeds.

Barley Yellow Dwarf Luteovirus

Occurs on tall fescue, and various *Poa* and *Festuca* spp. Occurs on cereal crops in Alaska.

Barley Yellow Streak Mosaic

Occurs on barley in Alaska.

Bayberry Yellows

Wavy margins and tips on young apical leaves, distorted margins on older leaves, which are pale, yellow, small. Plant is stunted, with shortened internodes, few or no fruits.

Bean Common Mosaic Potyvirus

Distributed worldwide in common beans wherever they are grown. Many strains of the virus were distinguished. They are transmitted by vectors, sap, pollen and seed. Virus is serologically related to 17 other Potyviruses.

Bean Mosaic = Bean Common Mosaic Potyvirus

Found wherever beans are grown, transmitted by many species of aphids – pean, cotton, cowpea, cabbage, peach, spirea, turnip – and in seed. First leaves are crinkled, stiff, chlorotic; older leaves have chlorotic mottling, often with leaf margins rolled down. Mosaic-resistant varieties include Robust, Great Northern, U.S. No. 5 Refugee, Idaho Refugee, and Wisconsin Refugee.

A strain known as bean greasy pod virus causes a greasy appearance of the pods in some western states. The asparagus-bean mosaic is a light and dark green mosaic with leaf rolling transmitted by seed and by the pea aphid. The virus may be a strain of bean mosaic virus or a different virus.

Bean Leaf Roll Luteovirus

Legume virus transmitted by aphids.

Bean Pod Mottle Comovirus

Systemic mottling in some varieties; circular, light brown local lesions on pods of other varieties. May also be seed transmitted in soybean.

Bean Southern Mosaic Sobemovirus

Chlorotic mottling or localized necrosis of foliage; pods with dark green blotches or shiny areas, slightly malformed, short, curled at end. Virus present in new seed but not in that stored 7 months.

Bean Yellow Mosaic Potyvirus

Mild Mosaic of Gladiolus. On beans, peas, sweet peas, clover, Tahitian bridal veil, gladiolus, false lupine, and freesia. In beans there is a coarse yellow mottling and distortion of leaves, which are pointed downward; proliferation of stems; shortening of nodes and general stunting; reduced pod production; delayed maturity. In pea and sweet pea there is veinal chlorosis, with slight ruffling. Gladiolus flowers are striped or flecked, young leaves have an angular green mottling, but symptoms are mild compared with the disease on beans and freesia, which should not be planted near gladiolus and clovers. The virus is transmitted by bean and pea aphids but not through seed. Rogue infected plants as soon as noticed.

Bean Yellow Stipple = Cowpea Chlorotic Mottle Bromovirus

Mild mottle and chlorotic spots on bean leaves, sometimes coalescing.

Beet 2 Alphacryptovirus

Transmitted only by pollen and seeds.

Beet Black Scorch

Necrovirus, Tombusriridae. Reported in Colorado.

Beet Curly Top Hybrigeminivirus

Confined to North America, curly top is especially important in the commercial sugar beet industry west of the Continental Divide, but it is common on many plants. Vegetables include bean, beet, carrot, celery, cabbage

and other crucifers, cucumber, melon, squash, pumpkin, eggplant, spinach, chard, New Zealand spinach, horseradish, and tomato. Ornamentals include alyssum, blue flax, campanula, carnation, columbine, coreopsis, cosmos, delphinium, foxglove, geranium, larkspur, nasturtium, pansy, petunia, poppy, portulaca, pyrethrum, scabiosa, Shasta daisy, stock, strawflower, veronica, and zinnia.

In beets there are clearing of veins, leaf curling, with sharp protuberances from veins on underside of leaf, increase in number of rootlets. In tomato, where the disease is called western yellow blight or tomato yellow, seedlings turn yellow and die. Older plants show twisting and upward rolling of leaflets, stiff and leathery foliage, with leaf petioles curling downward; branches and stems are abnormally erect; the whole plant is dull yellow, often with purple veins; roots are killed, few fruits formed.

In cucurbits, tips of runners bend upward; old leaves are yellow, tip leaves and stems abnormally deep green. In beans, there is a thickening and downward curling of first true leaf, which becomes brittle. The plant stops growing and may die. Older plants survive until the end of the season, with puckering and downward curling at the top of the plant, reduction in size of new leaves, shortened internodes.

Ornamentals grown near diseased beets are usually infected. Zinnias have shortened internodes, chlorotic secondary shoots arising from leaf axils. Cosmos leaflets are twisted and curled, petioles bent down. Geranium leaves are chlorotic between veins with protuberances on lower surface.

The virus is confined to phloem in plants and is transmitted by the beet leafhopper (*Circulifer tenellus*). The insects winter on weed hosts, laying eggs and maturing the first generation there before migrating in swarms, often hundreds of miles, to sugar beet fields. When the beets are plowed out, the hoppers migrate to neighboring gardens.

Control. Destruction of weed hosts helps somewhat, as does early planting. There are resistant varieties of sugar beets, none of table beets. Tomatoes are sometimes protected with temporary muslin tents. Infected plants must be destroyed.

Beet Distortion Mosaic Virus

Transmitted probably by a fungus *Polymyxa betae*; spreads in California.

Beet Latent Virus

A symptomless virus in beets.

Beet Mosaic Potyvirus

On sugar and table beets, spinach. Discrete yellowish lesions, then chlorotic mottling, darkening of vascular tissue; leaves bend back near the tips, which sometimes die. Transmission is by pea, peach, bean, and other aphids.

Beet Ring Mottle

On sugar beet and spinach; stunting, distortion, mottling; transmission by aphids.

Beet Necrotic Yellow Vein Tobamovirus

On sugar beet and transmitted by soil-borne fungus *Polymyxa betae*.

Beet Pseudo-Yellows Closterovirus

Yellowing of sugar beet, carrot, spinach, cucumber, lettuce, and ornamentals; transmission by greenhouse whitefly.

Beet Savoy

Leaves are dwarfed, curled down, with small veins thickened; roots have phloem necrosis. A plant bug (*Piesma cinerea*) is the vector.

Beet Western Yellows Luteovirus

In Europe known as Beet Mild Yellowing Luteovirus. More than 150 species from 23 families are susceptible. Virus-transmitted by insects but principal natural vector is *Myzus persicae*.

Beet Yellow Net Luteovirus

On beets and chard. Leaves have a yellow network of veins against a green background. Transmission by the peach aphid.

Beet Yellows Closterovirus

On beets and spinach. Outer and middle leaves are yellowed, thickened, brittle, with chlorotic areas waxy. Vectors are peach and bean aphids.

Bidens Mottle

On *Rudbeckia, Zinnia*, and *Ageratum*.

Bidens Mottle Potyvirus

On *Rudbeckia, Zinnia*, and *Ageratum*.

Blackberry Dwarf

►Loganberry Dwarf.

Blackberry Dwarfing

On brambles in California.

Blackberry Mosaic

Mottling, crinkling, vein clearing and distortion.

Blackberry Variegation

On raspberry and blackberry. Infected leaves are nearly white at maturity.

Blackeye Cowpea Mosaic

On urd bean.

Blueberry Leaf Mottle Nepovirus

Reported on cultivars Rubel and Jersey in Michigan. Virus is transmitted by pollen and by honeybees which carry the pollen.

Blueberry Necrotic Ring Spot

A strain of tobacco ring spot virus, causing stunting and distortion; transmitted by dagger nematodes.

Blueberry Necrotic Shock Ilarvirus

Leaf and flower necrosis symptoms occurred for 1–4 years, then plants recover and remain symptomless.

Blueberry Red Ring Spot Caulimovirus

Red spots and rings, oak leaf patterns.

Blueberry Ring Spot

A minor disease chiefly on Cabot with red rings and dots in leaves.

Blueberry Scorch Carlavirus

Transmitted by grafting, it caused marginal chlorosis and necrosis of leaves but some cultivars remain symptomless.

Blueberry Shoestring Sobemovirus

Symptoms of “shoestring disease” included reddish streak on stem, narrow strap-like leaves and flower breaking.

Blueberry Shoestring Sobemovirus

On highbush bluberry.

Blueberry Stunt Phytoplasma

Bushes are dwarfed with small leaves, yellowing in summer, brilliant red in fall; berries are small, poor. Transmission by a leafhopper (*Scaphytopius magdalensis*). Variety Rancocas is quite resistant; Harding is tolerant. Eliminate wild blueberries near cultivated.

Broad Bean Severe Chlorosis Closterovirus

Caused chlorosis, necrosis and leaf malformation on broad beans.

Broad Bean Wilt Fabavirus

Virus is the type species of genus. It is known also as a catalpa chlorotic leaf spot, tropaeolum, nasturtium and petunia ringspots, pea streak virus and parsley virus 3.

Broad Bean Wilt Fabavirus

Causes leaf mottle, ring spots, and poor growth of fibrous-rooted begonia; also found on clockvine, bean, lettuce, spinach, lambsquarter, ajuga, and dogwood.

Brome Grass Mosaic

Recently reported on Kentucky bluegrass, in Kansas.

Brome Mosaic Bromovirus

On cowpea.

Cabbage Black Ring Spot

► Turnip Mosaic Potyvirus.

Cabbage Ring Necrosis = Turnip Mosaic Potyvirus

On cabbage and other crucifers, also infecting petunia, zinnia, calendula, cucumber, beet, chard, and spinach. Concentric necrotic rings on leaves and irregular dark, slightly sunken lesions on stems.

Cactus X. Potexvirus

On night-blooming cactus (*Hylocereus*).

Calibrachoa Mottle Carmovirus

Chlorotic blotch, leaf mottling and interveinal yellowing on *Calibrachoa* species.

Camellia Yellow Mottle Varicosavirus

Infectious Variegation; Color-Breaking. A graft-transmissible disease with at least four strains; CV1 – large white spots on petals; CV2 – small white flecks on petals, leaf variegation; CV3 – feathery mottling of flowers; CV4 – slower variegation and leaf mottle.

Canna Mosaic

Leaves with irregular pale yellow stripes from midrib to margin, parallel with veins, may be wrinkled and curled with chlorotic areas often dusty brown. Stems, sepals, and petals have yellow bands. Transmitted by peach and other aphids.

Canna Yellow Mottle Badnavirus

Bacilliform virions, not enveloped, 120–130 nm length and 28 nm wide. Virus caused systemic veinal yellowing, mottling and chlorosis of *Canna* spp.

Carnation Etched Ring Caulimovirus

Causes an etched-ring pattern on carnation leaves.

Carnation Italian Ringspot Tombusvirus

It is synonym for carnation strain of Tomato Bushy Stunt Tombusvirus.

Carnation Latent Carlavirus

This virus is serolocicaly related to potato viruses S and M, chrysanthemum virus B and other carlaviruses.

Carnation Mosaic

Widespread on carnation and sweet william. Light and dark green mottling in young leaves is followed by yellow or necrotic spots or streaks. Flowers may be spotted or striped. The vector is the peach, not the carnation, aphid. Greenhouse fumigation helps in control.

Carnation Mottle Carmovirus

Common in commercial carnations but producing only faint leaf mottling and flower streaks; transmitted by root contact or cutting knife.

Carnation Necrotic Fleck Closterovirus

Severe necrotic flecking and streaking to mild yellow flecks on carnation.

Carnation Ring Spot Dianthovirus

Concentric rings on sweet william with vein clearing, then general mosaic; necrotic rings on carnation, often combined with reddening and curling of older leaves. Sap-transmissible on cutting knife.

Carnation Streak

A strain of Carnation Necrotic Fleck Closterovirus. Yellow or reddish spots and streaks parallel to veins; lower leaves turn yellow and die. Graft-transmissible.

Carnation Vein Mottle Potyvirus

The best test for diagnosis of this virus is immunosorbent electron microscopy technique.

Carnation Yellows

Foliage mottling, flower streaking due to combination of streak and mosaic viruses.

Carrot Motley Dwarf = Carrot Mottle Umbrarvirus

An Australian disease now present in California. Leaflets are small, chlorotic, with twisted petioles; plants are stunted, roots unmarketable. Vectors are aphids.

Carrot Red Leaf Luteovirus

Transmitted by aphids in persistent manner, but does not multiply in the vector. No transmission by sap, seeds, or pollen.

Carrot Thin Leaf Potyvirus

Caused vein clearing and malformation of leaves (narrowing).

Cassava Common Mosaic Potexvirus

Reported from Florida, virus is transmitted by mechanical inoculation and by grafting.

Cauliflower Mosaic Caulimovirus

Widespread on crucifers, broccoli, brussels sprouts, cauliflower, chinese cabbage, collard, kale, annual stock, and honesty. Clearing of veins in cauliflower is followed by mild chlorotic mottling, with veins usually banded by dark green necrotic flecks. Midribs are curled, leaves distorted, plants stunted, terminal heads dwarfed. Stock is rosetted, with shortened internodes. Transmission is by cabbage, false cabbage, peach, and other aphids.

Celery Calico

On cucumber, crookneck squash, tomato, celery, and larkspur. In celery there are vein clearing, puckering, and downward cupping of younger leaves, green islands in yellows areas of outer leaves, yellow and green zigzag bands on leaflets. Basal and middle leaves of delphinium have orange-amber or lemon-yellow areas, chlorotic ring and line patterns; younger leaves are normal green. Transmission is by many species of aphids – celery, celery-leaf, rusty-banded, cotton, erigeron-root, foxglove, greenpeach, and honeysuckle.

Celery Mosaic Potyvirus

On celery, celeriac, and carrot in California. Young leaflets are mottled green and yellow, in advanced stages narrow, twisted, cupped; plants are stunted, with central leafstalks shortened, outer in a horizontal position with rusty necrotic spots. Transmission is by many species of aphids. A crinkle leaf strain of this virus causes a yellow mottle with raised blister areas and crinkling on celery leaves.

Celery Yellow Dwarf Poleroviridae

Occurs on cereal crops in Alaska.

Celery Yellow Spot Luteovirus

On celery and parsnip in California. Yellow spots and stripes, mostly along veins; circular white spots on petioles; transmission by honeysuckle aphid.

Cherry Albino

On sweet cherry in Oregon. Branches die back in spring; leaves golden brown with up-rolled margins; late summer, new growth small and rosetted; fruit small and white; trees soon killed. Transmission by tissue union.

Cherry Bark Splitting

On sour cherry and apricot.

Cherry Black Canker

On sweet cherry, Oregon. Black, rough cankers on twigs and branches.

Cherry Buckskin

► Peach Western X-Disease (under Bacterial Diseases, Phytoplasma).

Cherry Bud Abortion

On sweet and sour cherry.

Cherry Chlorosis

On Malaheb and chokecherry.

Cherry Freckle Fruit Disease

On sweet cherry.

Cherry Green Ring Mottle

On sour cherry.

Cherry Gummosis

On sour cherry. Dieback of terminal shoots, excessive gumming of branches.

Cherry Little Cherry

On sweet and sour cherry; fruits are half-size. Flowering cherry acts as a reservoir for the virus.

Cherry Midleaf Necrosis

Dark brown necrosis starting in midvein; heavy leaf fall; trees small and less vigorous but fruit normal. On sour cherry in Oregon.

Cherry Mora

Abnormal delay of a month or more in ripening fruit; leaves yellowish, small, rosetted, twisted on fruit spurs. On sweet cherry, Oregon.

Cherry Mottle Leaf Trichovirus

On sweet cherry in Northwest. Leaves show chlorotic mottling, are puckered, wrinkled, distorted but not perforated. Fruit is small, hard, insipid, uneven or delayed in ripening; crop is reduced. Branches are shortened, trees stunted. Transmission by grafting or budding with no insect vector known, but the disease spreads from wild bitter cherry to sweet cherry. Remove diseased trees. Propagate with scions from virus-free trees.

Cherry Necrotic Rusty Mottle

On sweet cherry. Foliage and blossoms delayed in spring; brown necrotic or rusty chlorotic spots, often with shot holes and defoliation.

Cherry (Sour) Pink Fruit

Fruit bitter, pink; tree stunted; foliage pale.

Cherry Pinto Leaf

On sweet cherry. Chlorotic patterns of varying size with disease tissue changing to bright yellow or white. Transmission by budding.

Cherry Rasp Leaf Nepovirus

Transmitted by nematode *Xiphinema amerciana*. Virus differs from other cherry diseases that cause leaf enations.

Cherry Rasp Leaf Nepovirus

On sweet cherry, in Northwest. Enations, elongated protuberances from underside of leaves with depressed lighter areas on upper surface.

Cherry Ring Spot = Prunus Necrotic Ringspot Ilarvirus

On sour cherry, sweet cherry (tatter leaf), peach, plum, prune, widespread in Northeast. Chlorotic or necrotic rings and spots on leaves, with lacerations to give the tatter-leaf effect. Transmission by grafting or budding, and, to a small extent, seed. Control by testing budwood sources on a differential host, such as Shirfugen variety of *Prunus serrulata*, sensitive to all strains.

Cherry (Flowering) Rough Bark

On Kwanzan flowering cherry. Internodes shortened; leaves in clusters and arched downward from necrosis and cracking of midribs; bark deep brown, rough with longitudinal splitting; trees dwarfed.

Cherry Rugose Mosaic = Strain of Prunus Necrotic Ringspot Ilarvirus

On sweet cherry. General chlorosis of leaf between midvein and margin, with distortion; fruit yield reduced; fruits flattened, angular. Transmission by grafting; incubation 9 months.

Cherry Rusty Mottle

On sweet cherry. Many leaves turn bright yellow to red with islands of green, and drop before harvest; remaining leaves have yellow-brown spots, rusty appearance; fruit is small, late, insipid. Remove diseased trees. Select grafting material from virus-free trees.

Cherry Twisted Leaf

On Bing cherry, severe stunting, leaves small, distorted, distal portion bent abruptly downward; sometimes defoliation.

Cherry Vein Clearing

Sweet Cherry Crinkle. A viruslike disease but not transmissible; probably genetic. Clearing of veins throughout leaves or in localized areas; margins irregular; some leaves with elongated, slotlike perforations; small blisters on lower side of veins, upper silvery. Leaves may fold along midrib, wilt and drop in midsummer. Rosetting of some branches. Blossoms abnormally abundant, but fruit reduced, pointed, flattened on one side with swollen ridge.

Cherry Yellows = Prune Dwarf Ilarvirus

Widespread on sour cherry. Yellow areas enlarge to cover whole leaves; defoliation. Diseased leaves and fruit larger than on healthy trees, but yield reduced by half. Transmission by budding and through seed.

Chickpea Filiform Potyvirus

On chickpea. Found in Washington State, but there is no evidence of spread.

Chrysanthemum Aspermy

► Tomato Aspermy Cucumovirus.

Chrysanthemum Chlorotic Mottle Viroid

Widespread in greenhouses and gardens. Bonnie Jean, Ridge, and Delaware varieties are used as indicators.

Chrysanthemum Flower Distortion

Apparently not widespread in United States. Virus is carried without symptoms in leaves of White Wonder, but if this is grafted to Friendly Rival,

flowers are extremely dwarfed and distorted, with ray florets short, narrow, incurved, or irregularly curved.

Chrysanthemum Mosaic, Chrysanthemum B Carlavirus

Noordam's B, Keller's Q, and other virus strains are widespread in chrysanthemum with mild to severe leaf mottling and sometimes a brown streaking of flowers. Transmission is by grafting and by aphids. Control by indexing tips from heat-treated plants on reliable test varieties to make sure they are virus-free.

Chrysanthemum Ring Spot

Reported from Alabama in plants also afflicted with Stunt. Large yellowish chlorotic ring patterns, severe leaf dwarfing and distortion.

Chrysanthemum Rosette

A strain from symptomless Ivory Seagull produces veinbanding, crinkle, distortion, rosetting on Blazing Gold.

Chrysanthemum Stunt Viroid

Widespread in greenhouses and gardens. Symptoms vary with variety, but plants are dwarfed, with small flowers and leaves and bloom earlier than normal or later in some varieties. Blazing Gold, Blanche, Mistletoe, Dauntless, and Bonnie Jean often used as indicator varieties. Leaves of Blanche are crinkled, and Mistletoe has a "measles" pattern. Transmitted by dodder, sap-inoculation, grafting with incubation period 6 weeks or longer; no insect vector is known. Many plant species have been infected experimentally. Commercial growers go to great lengths to select and reselect a virus-free stock, and great care is taken to prevent recontamination. Garden varieties are now indexed and available.

Cineraria Mosaic

Mottling, dwarfing, and distortion of leaves, transmitted by seed, mechanically, and by *Aphis marutae*

Citrus Enation – Woody Gall Luteovirus

Found in different species of Citrus, Ulmus, Morus, Rosa, Prunus, Viburnum and Ecualyptus.

Citrus Exocortis Viroid

Probably same as Rangpur lime disease; in Florida and Texas on red grapefruit and sweet orange trees, on Rangpur lime and trifoliate orange rootstocks. Trees are stunted with bark shelling.

Citrus Leaf Rugose Ilarvirus and Citrus Variegation Ilarvirus

Disease known as citrus psorosis virus complex. Viruses spread in California and caused psorosis of young leaves and malformation of the old ones.

Citrus Leprosis Rhabdovirus

Transmitted by mite-vector *Brevipalpus phoenicis*.

Citrus Psorosis Complex: Citrus Leaf Rugose Ilarvirus, Citrus Ringspot Virus, Citrus Variegation Ilarvirus

Found wherever citrus is grown. Leaf symptoms are small elongated white or yellow areas near veins. Bark symptoms are scales or small pustules with irregular growth and gum deposits. With B strain of the virus, leaves have dots, rings, or large translucent areas and small corky pustules; fruit has surface rings. In the concave gum strain, cavities develop on trunks and larger limbs. The blind-pocket strain usually produces troughlike depressions in bark, sometimes bark scaling. The crinkly leaf strain, usually on lemon, causes warping and pocketing of mature leaves, and rough, bumpy fruit. Transmission is by budding or through natural root grafts.

Remove trees with advanced infection; use budwood from trees known to be free from psorosis. Sometimes bark can be scraped, going several inches beyond the margin of affected areas and painting the scraped areas with bordeaux paste.

Citrus Ringspot Virus

Caused epinasty, chlorotic flecks, leaf mottling Ringspot and large irregular chlorotic pattern on mature leaves of *Citrus* sp.

Citrus Stubborn Disease

Oranges have multiple buds, abnormal branching, acorn-shaped fruit, which is sour and bitter at the navel end.

Citrus Tatter Leaf Cappillovirus

Reported from California and Texas on Meyer lemon and lime. Blotchy spotting of younger leaves and ragged margins.

Citrus Tristeza Closterovirus

Quick Decline. In California, Florida, and Texas; usually in trees on sour orange rootstock. First symptoms are partial or complete suppression of new flushes of growth. Older leaves are dull or bronzed, later yellow. Defoliation continues progressively from base of twigs to tip. Rootlets and then roots die. Limbs die back, and weak shoots are produced from main limbs and trunk. Transmission is by melon and other aphids. Make new plantings with stock-scion combinations known to be resistant. Best rootstocks are sweet orange, rough lemon, Rangpur lime, and sweet lime.

Citrus Vein Enation

In California on sour orange, Mexican lime, and other citrus. Veins swell and enations develop on lower surface. Transmission by grafts and aphids.

Citrus Xyloporosis

Cachexia. In Florida, chiefly on sweet lime rootstock, but also on mandarins and some of the tangelo oranges. Symptoms include stunting of 2- or 3-year trees, small yellow leaves, partial leaf drop, early blooming and fruiting; horizontal growth of branches in middle section of trees; dieback, followed by

decay of entire trunk and roots. Fruits are more rounded, with a thicker rind. Transmission is by budding, possibly through seed. Use resistant rootstocks, as sour oranges of Israel and Bagdad, Valencia orange.

Citrus Yellow Vein

In California on limequat. Petioles and veins are bright yellow.

Clerodendron Zonate Ring Spot

In Florida on "bleeding-heart" vine. Chief symptoms are cleared veins.

Clover Club Leaf

On crimson clover. Young leaves are light-colored, have club leaf appearance due to delayed opening. Yellow margins of leaves turn red or purple during summer. Transmission by a leafhopper.

Clover (Alsike) Mosaic = Clover Yellows Vein Potyvirus

On pea, causing chlorotic spotting and dark green banding of veins, leaves slightly cupped or distorted. Leaf puckering and plant stunting on bean. Pea aphid is vector.

Clover (Red) Vein Mosaic Carlavirus

On garden pea, causing pea stunt, broad bean, sweet pea, and red clover. Vein clearing and chlorosis are chief symptoms with, on peas, curling of leaves and rosetting of younger shoots, wilting, and collapse. Vein clearing is the only symptom on sweet pea. Broad beans may be stunted and killed. Transmission is by the pea aphid without incubation period or long retention. The Wisconsin pea stunt virus may be a strain of the red clover virus.

Clover Yellow Mosaic Potexvirus

Transmitted by mechanical inoculation; serologically related to White Clover Mosaic, Cactus X and Hydrangea Ringspot Potexviruses.

Clover Yellow Vein Mosaic

On winged bean, wild carrot, poison hemlock, and red bean.

Clover Wound Tumor Phytoreovirus

Big vein disease, causing enlargement of veins, sometimes with enations, woody tumors on roots, sometimes stems. The virus was discovered accidentally in leafhopper nymphs and has been transmitted experimentally to many plants besides clovers.

Cocksfoot Streak Potyvirus

Caused chlorotic streaks on leaves of *Dactylis glomerata*.

Coleus Mosaic = Cucumber Mosaic Cucumovirus

Reported from Illinois on coleus, symptoms varying with variety. Leaves may be puckered, crinkled, asymmetrical, with oak-leaf markings or ring spots or small necrotic spots.

Commelina Diffusa Potyvirus and Commelina Mosaic Potyvirus

Both viruses infected *Commelina diffusa* and *Rhoeo spatecea* on which mosaic or systemic mottling symptoms occurred. Both viruses induced pinwheel structures in the cytoplasm.

Coriander Feathery Red Vein Nucleorhabdovirus

Virus multiplies in vectors (*Myzus perscicae and Hydaphis foeniculi*) and is transmitted congenitally to the progeny of the vector.

Corn Leaf Fleck

On field and sweet corn in California. Small, circular pale spots on leaves with tip and marginal burning, leaves dying 7 to 10 days after initial symp-

toms. Transmission by corn, peach, and apple grain aphid, which retain the virus for their entire lives.

Corn (Sweet) Mosaic

Leaves have broken or continuous interveinal chlorosis.

Cotton Leaf Curl Bigeminivirus

Caused chlorosis, thickening and malformation of veins, petioles and leaves on *Gossypium barbadense* and *Hibiscus esculentus* plants.

Cowpea Chlorotic Mottle Bromovirus

Reported in peanut, common bean, cowpea and soybean plants.

Cowpea Mosaic Comovirus

Clearing of veins is followed by chlorotic mottling, slight convex cupping of leaflets, shortened internodes, abortion of flowers, twisting of petioles, and delayed maturity. Yield is reduced. Vectors are potato, pea, and cotton aphids. Another cowpea mosaic, known in Trinidad and probably the same as one in the United States, is transmitted by bean leaf beetles. May infect soybeans, hoary-tick clover (*Desmodium canescens*).

Cranberry False Blossom

The most serious cranberry disease in Massachusetts, New Jersey, and Wisconsin; known also on the Pacific Coast. American and European cranberries are the only natural hosts, but the virus has been dodder-transmitted to other plants. Cranberry flowers are erect, instead of pendent, with calyx lobes enlarged, petals short, streaked with red or green, stamens and pistils abnormal. Flowers may be replaced by leaves or short branches. Axillary buds produce numerous erect shoots forming witches' brooms; diseased fruits are small and irregular. Transmission is by the blunt-nosed leafhopper. Select strains resistant to the vector or flood the bogs after leafhoppers have hatched. Spray with pyrethrum.

Crimson Clover Latent Nepovirus

Symptomless on *Trifolium incarnatum*.

Cucumber Mosaic Cucumovirus

General with many strains in cucumber, squash, melon, winged bean, periwinkle, wild violets, desert-rose, and a wide range of other plants, including spinach, where the disease is called blight; tomato, causing shoestring disease with filiform leaflets; pepper, petunia, grlic mustard, fuschia, and tobacco. Wintering is on ground cherry, milkweed, pokeweed, catnip, Texas bluebell and *Peristroph* sp. and other weed hosts. Transmission is by peach, cotton, potato, and lily aphids and, in some cases, through seed.

In cucurbits there is a yellow-green systemic mottling, with leaves small, distorted, curled, plants dwarfed with shortened internodes, few fruits set and those mottled and misshaped, a condition called "white pickle." The lily mosaic strain produces a masked infection or chlorotic mottling and necrosis when mixed with Lily Symptomless Virus. The lima-bean, southern celery mosaic, and cowpea strains cause chlorotic mottling.

Geraniums are stunted and mottled; gladiolus flowers are color-broken; dahlia foliage has oakleaf patterns; periwinkle (myrtle) has a streaky mottle, down-curved leaves, small flowers with a white streak in the blue color. Petunias have distorted leaf blades, few or no blossoms. In delphinium, which is very susceptible, the disease is called ring spot, stunt, witches' broom.

Control. Resistant varieties of spinach, cucumber, and squash are available. Diseased lilies and other flowers should be rogued immediately. Control aphids by systemic ground treatments or sprays; repel aphid vectors by an aluminum foil mulch. Lilies may possibly be freed of the virus by scale propagation.

Cucurbit Leaf Curl Begomovirus

On pumpkin, cucumber, muskmelon, honeydew, zucchini, banana squash, and squash.

Cucurbit Leaf Crumple Begomovirus

On cucumber.

Cucurbit Yellow Stunting Crinivirus

On melon.

Currant (Red) Mosaic = Tomato Ringspot Nepovirus

Irregular, light green circular spots along midrib and larger veins enlarge to bands. Canes are stunted; plants decline.

Cymbidium Mosaic Potexvirus

Virus was isolated from many orchid species showing mosaic symptoms. It is transmitted by contact between plants.

Dahlia Mosaic Caulimovirus; Stunt

General. Bands along midrib and veins remain yellow-green. In some varieties leaves are distorted and blistered; in others, leaves are yellowed with margins up-rolled; in others, plants are very short and bushy with short flower stems. Transmission is by peach and other aphids.

Dahlia Oakleaf

May be a separate entity or a strain of Tomato Spotted Wilt Tospovirus. A pale chlorotic line across the leaf suggests the outline of an oak leaf.

Dahlia Ring Spot

Caused by a strain of Tomato Spotted Wilt Virus Tospovirus. Leaves have concentric rings or irregular zigzag markings. In Utah a yellow strain causes bright yellow rings and zigzags.

Dasheen Mosaic Potyvirus

Widespread in plants from Araceae family.

Delphinium Ring Spot

Faint chlorotic rings around green and yellow centers appear on young leaves, irregular necrotic spots or rings with yellow bands on mature leaves.

Desmodium Mosaic Potyvirus

Transmitted by aphids, sap and seeds. Leaf sap contains only a few filamentous (775 nm length) virus particles.

Desmodium Yellow Mottle Tymovirus

Transmitted by mechanical inoculation. Leaf sap contains many isometric (30 nm diameter) virions.

Diodia Vein Chlorosis Closterovirus

Transmitted by *Trialeurodes abultilonea*; caused chlorotic vein banding and chlorosis of *Diodia virgianiana* plants.

Dodder Latent Mosaic

Three species of dodder transmit mosaic to cantaloupe, potato, tomato, and celery.

Dogwood Mosaic Nepovirus

Considered earlier as a strain of Arabis Mosaic Nepovirus.

Elderberry Disease = Elderberry Carlavirus, Elderberry Latent Carmovirus

A virus disease reported from golden elderberry can infect various stone fruits and is considered a potential threat to the fruit industry.

Elm Mosaic

On American elm in Ohio and eastern states. Some leaves are larger than normal, others small, distorted, with yellow and green mottling. There may be some branch brooming, gradual decline in vigor. Transmission is by grafting; no insect vector is known.

Elm Zonate Canker

On American elm, New Jersey, Ohio, Missouri. Zonate cankers appear in bark as rings of dead and living tissue in cortex or phloem. Some leaves develop brown necrotic spots. Transmission is by bark patch grafts; no insect vector is known.

Euonymus Mosaic

Infectious Variegation. Persistent yellowing along veins; transmission by grafting and budding.

Euphorbia Mosaic Begiminivirus

Spreads in Florida by nymphs and adults of *Bemisia tabaci*. Infected plants showed mosaic and leaf malformation.

Fig Mosaic

Systemic chlorotic mottling is accompanied by severe leaf distortion; fruits have light circular areas or rusty spots, may be deformed and drop prematurely. Transmission is by grafting and the fig midge (*Aceria ficus*).

Figwort Mosaic Caulimovirus

The viral DNA has little homology with that of Cauliflower Mosaic Caulimovirus.

Filaree Red Leaf Luteovirus

On *Erodium* in California. Early symptoms are mild vein clearing, outward curvature of petioles, inward cupping of leaflets. Later leaflets cup outward, with reddish discoloration, are brittle, with petioles stiffly upright; flowers are dwarfed or suppressed. Aphids are vectors. Caused vein clearing and chlorosis of young leaves; older leaves are red and breakable. Infected plants are stunted and do not develop flowers.

Foxtail Mosaic Potexvirus

Virus related to Narcissus Mosaic and Viola Mottle Potexvirus.

Geranium Chlorotic Spot

General on geranium. It is caused by tomato and tobacco ring spot nepoviruses.

Geranium Crinkle

Pelargonium Leaf Curl Tombusvirus. General on geranium. Hyaline spots are small, circular to irregular, sometimes star- or tree-shaped, with brown centers. Young leaves are crinkled, small, sometimes puckered and split; severely infected leaves turn yellow and drop. Petioles and stems have corky, raised necrotic streaks; tops may die. The disease is most severe in spring, inconspicuous in summer. Transmission is by grafting (not by knife preparing cuttings) and probably by whiteflies.

Geranium (Pelargonium) Mosaic

Leaf Breaking. Leaves smaller, with purple spotting along veins, and suppression of horseshoe pattern in foliage of some geranium varieties.

Gladiolus Mosaic

► Bean Yellow Mosaic Potyvirus.

Grapevine Fanleaf Nepovirus

Infectious degeneration in California; Court-noué and Roncet in Europe. New growth is severely stunted; leaves are dwarfed and puckered or with deep indentations and folded like a half-closed fan; fruit set is poor. The virus is present in soil and can be transmitted, apparently, by nematodes.

Grapevine Fleck Virus

Generally symptomless in most cultivars; transmitted only by grafting.

Grapevine Rupestris Vein Feathering Marafivirus

On grape.

Grape Leaf Roll = Grapevine Leafroll-Associated Closterovirus

White Emperor Disease. In California, restricted to Emperor variety. Fruit is greenish yellow or pink rather than normal red; leaves are darker than normal, turning bronze or reddish along veins, yellow between veins.

Grapevine Stem Pitting Associated Chlosterovirus

Virions (800 nm length) found in phloem, but they are very difficult to extract from host tissue. Virus related only to Citrus Tristeza Closterovirus.

Grape Yellow Mosaic F Strain of Grapevine Fanleaf Nepovirus (Panachure)

Yellowing of leaves of young shoots in some varieties; various types of leaf mottling; blossom shedding. Transmission by grafting and in soil.

Grape Yellow Vein = Tomato Ringspot Nepovirus

Can be transmitted by dagger nematodes.

Guar Symptomless Potyvirus

Symptomless or caused mild green mottle on *Cyanopsis tetregonoloba*.

Hellenium S. Carlavirus

Hellenium and Impatiens strains differ in host range and aphid transmissibility.

Henbane Mosaic

Clearing or yellowing of veins of youngest leaves, then a yellow mosaic and dark green vein banding.

Hibiscus Chlorotic Ringspot Carmovirus

Caused very variable symptoms on the leaves of *Hibiscus rosa-sinensis*; from mottling and chlorotic spots to vein banding and rings.

Hibiscus Latent Fort Pierce Tobamovirus

On *Hibiscus*.

Hippeastrum Mosaic Potyvirus

Virus known also as Amaryllis Mosaic Virus, caused chlorotic streaking on leaves and flower stalks.

Hollyhock Mosaic

Pronounced yellow and green mottle on hollyhock and malva.

Holodiscus Witches' Broom

On ocean spray. Diseased branches form clusters of thin, wiry shoots with abnormally short internodes, crowded small leaves; foliage turns bronze red early. Transmission by the spirea aphid and by grafting.

Hop American Latent Carlavirus, Hop Latent Carlavirus, Hop Mosaic Carlavirus

All three carlaviruses are distantly serologically related. Usually they are symptomless or show mild mosaics.

Hyacinth Mosaic Potyvirus

Spreads by aphids. Virus caused chlorotic spots on leaves, stunt and color-breaking of flowers.

Hydrangea Latent Carlavirus

Reported on *Hydrangea macrophylla* in U.S.A.

Hydrangea Phyllody Phytoplasma

Witches' Broom, "green" flowers.

Hydrangea Ring Spot Potexvirus

Chlorotic blotches and rings, brown rings and oak-leaf patterns are common in florist's hydrangea. A probable cause of hydrangea "running out." Transmission is by cutting knife. Virus can infect snapdragon, sweet william and globe amaranth.

Iris Fulva Mosaic Potyvirus and Iris Severe Mosaic Potyvirus

Both potyviruses are spread generally by aphids. For diagnostic purposes they can be easily separated by pinwheel inclusions morphology.

Iris Mosaic = Iris Mild Mosaic Potyvirus

Widespread on bulbous iris, especially serious on Pacific Coast. Plants are stunted with yellowish streaks on leaves and dark, teardrop markings on white, blue, or lavender flowers, clear feathery markings on yellow flowers. Transmission is by peach and potato aphids. Establish disease-free foundation stock; rogue all diseased plants; spray for aphids.

Iris Yellow Spot Tospovirus

On *Allium* sp. Including *A. cepa*.

Impatiens Latent Potexvirus

Symptomless virus transmitted only by mechanical inoculation.

Impatiens Necrotic Spot Tospovirus

Previously called strain of Tomato Spotted Wilt Tospovirus. It is the most common and most damaging virus in the greenhouse industry. The virus has an extremely broad host range and its vector, the western flower thrips, *Frankliniella occidentalis*, are widespread and difficult to control. Symptoms caused by virus were variable but generally occurred as brown or black necrotic spots, blotch, necrotic rings on leaves and flower distortion. Often the center leaves collapse. Infected plants are stunted and die prematurely. The control of vector is essential in greenhouses.

Ixia Mosaic

Perhaps iris mosaic.

Johnsongrass Mosaic Potyvirus

Known also as Maize Dwarf Mosaic Virus strains 0 and Kansas and as Sugarcane Mosaic Virus. On Johnsongrass virus caused systemic mosaics.

Kalanchoe Top-Spotting Badnavirus

Kalanchoe blosfeldiana plants showed sunken yellow spots and sometimes leaf deformation.

Laburnum Mosaic

Infectious variegation. Bright mottling of foliage, often with veins picked out in yellow.

Lettuce Big Vein Varicosavirus

Transmitted by a vector-fungus, *Olpidium brassicae*. Vein clearing followed by enlarging and bleaching

Lettuce Infectious Yellows Closterovirus

Virus infected lettuce, sugarbeets, cantaloupe, watermelons, melons, squash, and carrots. Main symptoms included chlorosis, reddening and brittle leaves; plants stunted.

Lettuce Speckles Mottle Umbravirus

Virus in mixed infection is encapsidated in coat protein of Beet Western Yellows Luteovirus.

Lettuce Mosaic Potyvirus

Widespread on lettuce. Leaves mottled, deformed, yellowed, browned; plants stunted or dead. Transmission is by peach and root aphids and in seed. Control vectors, use virus-free seed; rogue seedbeds.

Lilac Mottle Carlavirus

Caused leaf chlorosis and mottling on *Syringa* spp.

Lilac Ring Spot Carlavirus

Pale green to yellow spots, lines, broad diffuse rings, and bands on lilac leaves, often with distortion and holes in tissue.

Lilac Witches' Broom Phytoplasma

On lilac, privet in Maryland. Brooming symptoms; lateral buds produce two to six slender shoots, which branch freely, with very small leaves on Japanese lilac. In common lilac and Regal privet there is yellow vein clearing with less prominent brooming. Transmission by grafting, and by dodder; no insect vector known.

Lily Color Adding

On lily.

Lily Color Removing

On lily.

Lily Fleck

Caused by Lily Symptomless Carlavirus and Cucumber Mosaic Cucumovirus. Yellow flecks on Easter lily leaves change to gray or brown, elongating parallel to veins; surface is depressed but unbroken. Plants are dwarfed with curled leaves, flowers small with brown streaks.

Lily Latent Mosaic

In Easter lily and tulip, symptoms masked or systemic chlorotic mottling.

Lily Mottle Potyvirus

It is a lily strain of Tulip Breaking Potyvirus.

Lily Ring Spot = Cucumber Mosaic Cucumovirus

Possibly a form of cucumber mosaic. There is only a faint mottling on some species, but on *Lilium tigrinum* and *L. regale* dark ring markings develop into necrotic areas. The growing point is killed; no flowers are formed; whole plant is twisted, stunted, deformed. Peach aphid is the vector.

Lily Rosette

Yellow Flat. On Easter lily. Leaves curl downward; plants are dwarfed, yellowed, mature early; bulbs are small. Transmission by the melon aphid, not by seed. Rogue diseased plants; spray for aphids.

Lily Symptomless Carlavirus

Present in Easter lilies wherever grown commercially but producing no symptoms alone; in combination with Cucumber Mosaic Cucumovirus causing necrotic fleck. Transmission by melon aphid.

Locust Witches' Broom

Brooming disease on locust from Pennsylvania to Georgia, Ohio, and Tennessee. Vein clearing is followed by reduction in size of new leaves, growth of spindly shoots to witches' brooms. Roots are more brittle, shorter, and darker than normal; rootlets branch excessively to root brooms. Transmission is by budding and grafting; no insect vector is known.

Loganberry Dwarf

Blackberry Dwarf. On loganberry and phenomenal blackberry in Northwest. Leaves are small, obovate, rigid, with new canes short and spindly. Young plants have crinkled leaves with some chlorosis or necrosis along veins. Flowers are small, drupelets ripen unevenly and tend to fall apart when fruit is picked. Transmission is by aphids.

Lolium Latent Potexvirus

On ryegrass (*Lolium perenne* and *L. multiflorum*).

Lonicera Infectious Variegation

Vein yellowing and variegation on honeysuckle; graft-transmitted.

Maize Dwarf Mosaic Potyvirus

First noted in Ohio in 1962 and since devastating to corn in many states. Red to purple streaks in upper leaves, ears usually incomplete; plants dwarfed with great reduction in yield. Transmission by corn leaf and peach aphids. Occurs also on *Sorghum* sp. and *Triticum* sp.

Maize Chlorotic Mottle Machlovirus

Usually occurred together with many potyviruses on infected maize plants showing severe systemic necrosis and stunting. Plant often dying.

Maize Rayado Fino Marafivirus

Initially described as a strain of Corn Stunt Virus now in the type species of Marafivirus. Virus frequently occurred in mixed infection with Phytoplasmas. It is multiplied in the vector, *Dalbulus maydis*, Cocadellidae and is not transmitted by sap, grafting or seeds.

Maize Stripe Tenuivirus

Caused yellow striping and chlorosis on natural hosts. *Zea mays, Sorghum vulgare, S. bicolor, Triticum aestivum* and *Hordeum vulgare*.

Maize Stunt = Maize Chlorotic Dwarf Waikavirus

► Corn Stunt.

Maize White Line Mosaic

On field corn and weed hosts including *Panicum, Setaria* and *Digitaria*.

Malva Vein Clearing Potyvirus

Caused vein clearing and yellow mosaics on many *Malva* and *Lavatera* species. Virus is known as Malva Mosaic, Malva Green Mosaic or Malva Yellow Vein Mosaic Virus.

Melon Leaf Curl Bigeminivirus

Caused leaf mottling and chlorosis on Cucurbits.

Melon Necrotic Spot Carmovirus

Transmitted by fungus *Olpidium radical*, by sap, by contact between plants and by seeds. It caused chlorotic and necrotic spots on Cucurbits.

Mimosa Striped Chlorosis Badnavirus

Infected *Albizzia* sp. plant showed chlorotic stripes along leaf vein and interveinal chlorosis.

Mint Crinkle Closterovirus

On golden ginger mint.

Mirabilis Mosaic Caulimovirus

Genome consists of DNA, virus-transmitted in semi-persistent manner by aphid, *Myzus persicae* and by sap.

Muskmelon Mosaic = Squash Mosaic Comovirus

Widespread on melon. First leaves have dark green bands parallel with main leaf veins; later leaves are mottled, sometimes deformed. Transmitted by seed and sap; insect vectors unknown

Muskmelon Vein Necrosis Carlavirus

Caused vein necrosis and leaf chlorosis on cucumber and pea plants.

Mustard Mosaic

On black mustard, California. Small, brown local lesions are followed by a general mottling.

Nandina Mosaic Potexvirus

Occurs in California; transmitted by mechanical inoculation.

Narcissus Chocolate Spot

Often present with white streak in a decline complex.

Narcissus Flower Streak

Strong breaking of flowers but normal foliage in Oregon bulb crops.

Narcissus Mosaic Potexvirus

Widespread on narcissus, but with mild symptoms, seldom apparent before plants bloom; has been confused with yellow stripe.

Narcissus White Streak

Silver Leaf. Paper tips and white streaks in leaves are primary symptoms, with wilting and falling over of foliage long before harvest so bulbs are small.

Causes decline combined with chocolate spot. Transmission by aphids. Replant only the largest bulbs.

Narcissus Yellow Stripe Potyvirus

Strong yellow streaking and mottling of foliage, often roughened near veins and with a peculiar twist. Flowers are streaked. Transmission by several species of aphids. Select the best plants for a mother block, with final selection during bloom; rogue plantings early before symptoms are masked by hot weather.

Nasturtium Mosaic Potyvirus

Vein clearing, ruffling and cupping of young leaves, dark green vein banding in older leaves, sometimes chlorotic spots or white rings between veins. Flower color may be broken, petals crinkled. Transmitted by several aphids.

Nothoscordum Mosaic Potyvirus

False garlic (wild amaryllis) mosaic transmitted through bulbs but not seed. Typical mosaic mottling of foliage.

Oak Ringspot Virus

Caused mosaic, chlorotic ringspot and oak leaf pattern on the older leaves.

Oat Blue Dwarf Marafivirus

Synonym for Flax Crinkle Virus transmitted by aster leafhopper. Infected *Avena* sp. plants turned deep blue.

Oat Golden Stripe Furovirus

Transmitted by fungus, *Polymyxa graminis*; systemically infected *Avena* sp. plants.

Oat Mosaic Bymovirus

Only *Avena* sp. are susceptible (developing mottle). Virus transmitted by fungus, *Polymyxa graminis*.

Odontoglossum Ringspot Tobamovirus

It is synonym for orchid strain of Tobacco Mosaic Tobamovirus.

Onion Yellow Dwarf Potyvirus

Yellow streaks develop at base of leaves, with yellowing crinkling, and flattening of new leaves. Leaves may be prostrate, flower stalks bent, twisted, and stunted; yield is reduced. Some species are relatively tolerant; tree onions are symptomless. Bean, apple-grain, corn leaf, and other aphids are vectors. Control is by indexing, growing sample lots of sets and mother bulbs in greenhouse beds or production of virus-free stocks in areas where disease is absent, and roguing of infected volunteer onions. Some varieties are resistant to the onion strain of the virus but not to the strain from shallot or garlic.

Opuntia Sammons' Tobamovirus

Symptomless on *Opuntia* spp., virus is transmitted only by mechanical inoculation.

Orchid (Cattleya) Blossom Brown Necrotic Streak

Brown spots, streaks of whole flower; leaves may have yellow streaks; transmission by knife. In removing flower spikes use "hot knife," with attached propane torch.

Orchid Fleck Rhabdovirus

Caused chlorotic and necrotic fleck on many orchid species. Virions are typical rhabdo or bullet-shaped.

Orchid (Cattleya) Mosaic Potexvirus

Flower-Break. On *Cattleya* and other orchids. There are apparently two diseases: mild color break, with variegation in the flower but no distortion, and severe color break, with flowers distorted or twisted as well as variegated. Leaves are mottled and sometimes twisted. The virus may be present in apparently healthy plants but can be detected with antisera, and infected plants removed. Transmission is by the green peach aphid.

Orchid (Cymbidium) Mosaic Potexvirus

Black Streak; Cattleya Leaf Necrosis. The most common virus disease on many kinds of orchids. On *Cymbidium* there is initially a mosaic mottle, then necrotic spots, streaks, and rings on leaves but no effect on flowers. In *Cattleya* there are sunken brown to black leaf patterns, sometimes rings, more often elongated streaks on older leaves. If leaves are killed prematurely, flowers are fewer and smaller but normal in form and color. No insect vector is known.

Orchid (Odontoglossum) Ring Spot Tobamovirus

On *Odontoglossum* only. Small, necrotic spots and rings on older leaves, light green to yellow areas on young leaves. Leaves may turn yellow and drop in 2 or 3 months or persist longer. There are no flower symptoms; no insect vector is known.

Orchid (Oncidium) Ring Spot

On mature leaves of *Oncidium*; round to irregular, slightly sunken yellow areas on both leaf surfaces; becoming necrotic with age.

Orchid (Vanda) Ring Spot

On 22 cultivated orchid species.

Ornithogalum Mosaic Potyvirus

On ornithogalum, galtonia, hyacinth, lachenalia, agapanthus, hebe, fine light and dark green leaf mottling becomes gray or yellow as leaves mature. Flower stalks are marked with light and dark green blotches; there are thin longitudinal streaks on perianth segments. Transmission is by melon, peach, potato and lily aphids.

Palm Mosaic Potyvirus

Infected *Washingtonia robusta* plants showed mosaics, ringspots and line pattern. Plants are often stunted.

Panicum Mosaic Sobemovirus

On St. Augustine grass.

Papaya Mosaic Potexvirus

Caused mosaic and stunting on *Carica papaya*.

Papaya Ringspot Potyvirus

Symptoms on infected *Carcia papaya* plants included mottling, malformation of leaves and streaking on flowers and fruits.

Pea Enation Mosaic Enamovirus

On pea, sweet pea, broad bean, soybean and sweet clover. Symptoms are yellowish spots on leaves, which are later white, with crinkling and savoying. Very susceptible varieties like Alderman have necrotic spots and proliferations or enations from underside of leaves. Pods may be markedly distorted and twisted with seeds small and yellow. Transmission is by pea, potato, and peach aphids.

Pea Mosaic Potyvirus

On pea, sweet pea, red clover and broad beans. Sweet pea has leaf mottling, chlorosis, breaking of flower color. Garden pea has vein clearing followed by mottling or general chlorosis and stunting. Transmission is by pea, peach and bean aphids. Perfection and Horal varieties are resistant to this virus but not to pea enation mosaic.

Pea Mottle

Pea Mottle caused by Clover Yellow Mosaic Potexvirus and Clover Yellow Vein Potyvirus. Fairly widespread on garden pea, snapbean, white clover and broad bean. On pea a severe systemic mosaic may be fatal. Some plants have chlorotic mottling of leaves and stipules, but stems, pods, and seeds are normal. Bean and pea aphids are probably vectors.

Pea Streak Carlavirus

Light brown to purple, oblong, necrotic lesions are scattered along stems and petioles with stems often girdled. Leaves and pods are roughened with light brown necrotic areas.

Pea Wilt

Causing severe streak in pea if pea-mottle virus is also present.

Peach Asteroid Spot

Discrete, chlorotic lesions spread along veins forming starlike spots; some chlorophyll is retained in lesions as leaves turn yellow.

Peach Calico

Leaves are first mottled, then yellowed, then papery white. Creamy white streaks develop on twigs. Fruit is shorter, rounder, with creamy white to red patches. Transmission is by budding.

Peach Dwarf

Only on Muir peach. Profusion of large, flat, dark green leaves, closely appressed on short twigs; witches' broom showing in dormant period; fruit larger than normal, misshapen.

Peach Golden Net

Probably identical with line pattern.

Peach Little Peach

Related to peach yellows, and in same host range, eastern United States.

Peach Mosaic

In Southwest on peach, apricot, nectarine, plum and capable of infecting almond. Spring growth of peach has short internodes, with sometimes flower breaking, chlorotic mottling, and foliage distortion early in the season, with masking of symptoms or dropping out of affected areas in midsummer. Fruit is small, irregular in shape, unsalable. Apricot stones have white rings and blotches. Transmission is by budding, grafting, a mite (*Eriophyes insidiosus*), and perhaps the plum aphid. Removal of infected trees, nursery inspection and quarantine reduce the incidence of mosaic.

Peach Mottle

Known only in Idaho.

Peach Necrotic Leaf Spot

On peach but with sweet cherry as a symptomless carrier. Light brown, dead, membranous areas in unfolding leaves fall out, leaving holes. The disease is recurrent on peach.

Peach Phony Disease

The most important peach disease in the Southeast. Trees are dwarfed; foliage is abnormally green, fruit small; there are flecks in wood, especially in roots. Phony trees have short terminal and lateral twigs; profuse lateral branching. Growth starts in spring earlier than on normal trees. Production gradually decreases, with trees worthless in a few years. Transmission is by root grafting and sharpshooter leafhoppers. Control has been by eradication and by quarantine to restrict movement of nursery stock.

Peach Red Suture

Probably a form of yellows. On peach and Japanese plum. Fruit ripens prematurely with softening, swelling, and red blotching on the suture, flesh coarse and watery while rest of fruit is hard and green. Eradicate diseased trees; propagate from healthy budwood.

Peach Ring Spot Ilarvirus

►Cherry Ring Spot.

Peach Rosette

On peach and plum. Trees suddenly wilt and die, or there are abnormally short stems bearing dwarfed leaves, with veins cleared and thickened; death follows in a few months. The virus can be inactivated by heating at 122°F for 10 minutes.

Peach Rosette Mosaic Nepovirus

Of minor importance on peach, highbush blueberry, and plum. Delayed foliation, chlorotic mottling, rosetting of shoots, dark green color; transmission by grafting and through soil. Eradicate trees; do not replant in same soil without fumigation.

Peach Stubby Twig

A new disease of peach and nectarine in California. Chlorotic leaves, stubby twig growth, decreased fruit production; transmitted with infected budwood.

Peach Wart

Foliage is normal but fruits are blistered, welted, and have conspicuous raised warty outgrowths. Tissues are light tan to red, rough, cracked, and russeted or smooth, with severe gumming. Transmission by budding or inarching.

Peach Yellow Bud = Tomato Ringspot Nepovirus

Winter's Peach Mosaic. On peach, apricot and almond in California. Pale yellow, feather-edged blotches along the midvein with leaf distortion, and defoliation near base of shoots. Transmission is by grafting. In field spread is only to adjacent trees, perhaps through soil.

Peanut Mottle Potyvirus

On wild peanut (*Arachis chacoense*).

Peanut Stunt Cucumovirus

First noted on peanuts in Virginia in 1964 and also occurs in bean, red and white clover. Severe dwarfing and malformation of foliar parts and suppression of fruit development. Transmission by grafting and green peach aphid.

Peanut Top Paralysis Potyvirus

Found in Oklahoma but there is no evidence of spread.

Pear Decline Phytoplasma

A relatively new and devastating disease in California, Oregon, and Washington, trees showing a slow decline or rapid collapse. First thought due to

a toxin of the pear psylla (*Psylla pyricola*), now considered a virus disease transmitted by the psylla.

Pear Stony Pit

On Bosc and other pears in Pacific Northwest. Dark green areas appear just beneath epidermis of fruit, 10 to 20 days after petal fall, resulting in deeply pitted or deformed fruit at maturity, with corky or necrotic hard tissue at base of pits. The fruit is gnarled, hard to cut. Transmission is by grafting; no insect vector is known. Bosc and Anjou pears can be top-worked with Bartlett to reduce losses from stony pit.

Pelargonium Flower Break Carmovirus and Pelargonium Line Pattern Carmovirus

Viruses are usually symptomless on *Pelargonium* or caused by flower streaking, line pattern or chlorotic spotting. They are transmitted by grafting and by contact between plants.

Peony Leaf Curl

Plants half normal height, with crooked flower stalks, curled leaves. Transmission is by grafting but not contact; no insect vector is known.

Peony Ring Spot = Tobacco Rattle Tobravirus

Marked yellow mosaic, irregular or in rings, sometimes small necrotic spots.

Peperomia Ring Spot

Concentric brown, necrotic rings on leaves, which may be cupped, curled, or twisted and may fall. Severely affected plants are stunted. Grower losses in Florida may be 25%. Take cuttings from healthy, vigorous plants.

Pepper Mild Mottle Tobamovirus

Infectious virus particles were found in water for greenhouse irrigations.

Pepper Mild Tigre' Bigeminivirus and Pepper Texas Bigeminivirus

Both viruses are transmitted by *Bemisia tabaci* and spread in Texas and Mexico.

Pepper Strain of Alfalfa Mosaic

On pepper.

Pepper Vein Banding Mosaic

Probably caused by Potato Y Potyvirus, a new disease in Florida. Plants are stunted with up to 50% loss of marketable fruit. Vein clearing and banding on leaves, fruit roughened with chlorotic spots or stripes. Transmission is by green peach and melon aphids. Eradicate deadly nightshade as a weed host for 150 feet from peppers, or use sunflower as a barrier.

Pepper Mottle Potyvirus

On pepper.

Phlox Streak

Streaks evident in leaves and stems. Clearing of veins is followed by necrosis in leaf veins and petioles. Graft-transmissible.

Physalis Mosaic Tymovirus

Known as Belladonna Mottle Virus caused by systemic mosaic or mottle.

Pigeon Pea Golden Mosaic Begomovirus

On pigeon pea.

Pineapple Wilt – Associated Closterovirus

Occurs in the Hawaiian pineapples causing yellowing and flecks on leaves, leaf tip necrosis and plant wilt.

Plantago Mottle Tymovirus

Related to Andean Potato Latent, Dulcamara Mottle, Belladonna Mottle, Onion Yellow Mosaic and Turnip Yellow Mosaic Viruses.

Plum Line Pattern = Plum American Line Pattern Ilarvirus

On plum, oriental cherry, widespread. Some plum varieties have yellow vein banding, brilliant green and yellow patterns of the oakleaf type, formed by single or multiple irregular lines or bands; in early summer the yellow fades to creamy white. In other varieties patterns are faint or absent. On flowering cherries discolored areas are bounded by a chlorotic band. Transmission is by budding or grafting.

Plum White Spot

Small pale yellow to white spots, mostly aggregated near leaf tips on Santa Rosa plum.

Poinsettia Mosaic Tymovirus

Caused systemic leaf mosaic and malformation and discoloration of bracts.

Poplar Decline Potyvirus

Pinwheel structures are induced in infected cells. Main disease symptoms are chlorotic and necrotic leafspots, necrosis of leaves and death of branches and even whole trees.

Poplar Mosaic Carlavirus

Many cultivars are symptomless or they develop mosaics or necrosis. Virus usually occurs alone in infected poplar trees.

Potato A Potyvirus

Known as Potato Mild Mosaic, Potato Virus P and Solanum Virus 3. Transmitted by aphids in non-persistent manner. Virus caused no symptoms.

Potato Acropetal Necrosis

Caused by potato viruses Y and X.

Potato Aucuba Mosaic Potexvirus

Bright yellow mottle in most varieties, sometimes necrosis of tubers.

Potato Bouquet Disease

Caused by Tobacco Ring Spot Nepovirus.

Potato Calico

Caused by strain of Alfalfa⟍Mosaic Alfamovirus.

Potato Crinkle

Mild Mosaic. Due to Potato Virus X plus A. Leaf mottling and crinkling are often inconspicuous, but plants die prematurely. Plant healthy tubers; isolate seed plots. Varieties Katahdin, Chippewa, Houma and Sebago are resistant.

Potato Green Dwarf

Caused by a strain of Beet Curly Top Hybrigeminivirus. Terminal growth is dwarfed and deformed; leaflets cupped upward.

Potato Leaf Roll Luteovirus

Important wherever potatoes are grown. Symptoms show about a month after plants appear above ground. Leaves are thick, leathery, rolled, with excessive starch; sometimes with a reddish or purple discoloration on the underside. Plants are dwarfed; tubers are few, crisp, with net necrosis – brown strands of dead tissue – in some varieties; sprouts are spindling; yield may be reduced one-half. Transmission is by peach and other aphids.
Use certified seed potatoes. These come from a foundation stock obtained by indexing. Seedpieces or tubers are planted consecutively in a row, and if any show virus symptoms, the whole unit is destroyed.

Potato Leaf Rolling Mosaic = Potato M Carlavirus

Leaves are mottled, flaccid, with some upward rolling but without distinct rolling, rigidity of leaf roll. Transmission by peach, potato and geranium aphids.

Potato Mottle

Caused by potato X potexvirus.

Potato Rugose Mosaic

Caused by potato Y potyvirus, often with PVX. Leaves are crinkled, mottled; lower leaves with black veins; plants are stunted, die prematurely. Control by careful roguing.

Potato S Carlavirus

Generally symptomless in most potato cultivars.

Potato Spindle Tuber Viroid

General on all tested varieties of potatoes. Plants are more erect than normal but spindly, lacking vigor. Stems are stiff, leaves small, dark green; tubers are

elongated, pointed at the end, the eyes "staring". Symptoms are accentuated by high soil moistures. Transmission is by contaminated knives in cutting, by contact between freshly cut seed pieces. Control by using certified seed.

Potato Vein Banding = Potato Y Potyvirus

On potato and many other hosts, transmitted mechanically and by many aphids. On some varieties there is leaf drop and necrotic streak or chlorotic mottling; on others there is no sign of disease.

Potato Virus A

Present in nearly symptomless form in some varieties, causing crinkle with virus X.

Potato X Potexvirus

Almost universally present in commercial potato stocks. Cause of latent mosaic.

Potato Witches' Broom

Apical leaves are slightly rolled, upright, light green with reddish or yellowing margins. There is proliferation of axial buds with tendency to bloom and set fruit; there are aerial tubers and numerous small subterranean tubers. Such tubers put out spindle shoots without a rest period and produce dwarfed, very bushy plants with small, round, or heart-shaped leaves. Use certified seed potatoes.

Potato Yellow Dwarf Nucleorhabdovirus

Formerly causing heavy losses in Northeast but now mostly controlled by seed certification. Potato leaves are rolled and yellowed; the plant is dwarfed with split stems showing rusty flecks. Transmission is by clover leafhoppers; overwintering hosts are ground cherry, oxeye daisy, vinca and other plants.

Potato Yellow Spot

Reported from Maine, mostly on Katahdin variety. Spots are small, circular, bright yellow, chiefly on lower leaves.

Primrose Mosaic

Plants are chlorotic, stunted, rugose, with upward, sometimes downward, cupping of leaves. Petioles and peduncles are shortened; flowers are white-streaked; leaves are coarsely mottled yellow-green, with green islands; tips of leaves are narrowed. No insect vector is known.

Privet Ring Spot

Reported on privet in Texas. Leaves are smaller, lighter green, drop early.

Prune (Standard) Constricting Mosaic

Spots are concentrated in a band across tip of the leaf; this area is killed, and all tissue except the midvein drops out.

Prune Diamond Canker

Symptoms expressed only on French prune – diamond or oval excrescences on secondary branches, often excess sprouts from body of tree.

Prune Dwarf Ilarvirus

On prune, plum, cherry and peach. Leaves are small, narrow, rugose, distorted, glazed. Internodes are short, but some branches escape and appear normal. Blossoms are numerous, but mature fruits few; pistils are aborted, petals narrowed. Most injurious to Italian prune, symptomless in Bradshaw and damson plums. Transmission by grafting and budding.

Prunus Necrotic Ringspot Ilarvirus

Very common in sweet cherry and plum orchards, worldwide. Its natural hosts are species from *Prunus, Rosa, Humulus* and *Cucumis*. Earlier virus was described as Plum Line Pattern, Peach Ringspot, Prunus Ringspot, Red Currant Necrotic Ringspot, Rose Chlorotic Mottle, Rose Line Pattern, Rose Vein Banding and Sour Cherry Necrotic Ringspot. Virus is transmitted by grafting, by seeds and by pollen to seeds and to the pollinated plants.

Quail Pea Mosaic Comovirus

Caused mosaics on *Streptostyles helvola* as well as on soybean and common bean plants.

Radish Mosaic Comovirus

Chlorotic spotting and mottling of foliage; plants not stunted.

Ranunculus Mottle Potyvirus

Caused foliar mottling and distortion on *Ranunculus asiaticus* plants.

Raspberry Alpha Leaf Curl Luteovirus

Common on red raspberry. Veins are retarded in growth, causing downward curling and crinkling of leaves. Foliage is dark green, but bronzed in late summer with glistening surface. Berries are small, poor; diseased canes are readily winter-killed. Transmission is by small raspberry aphid (*Aphis rubiphila*). Cuthbert variety is most susceptible. Rogue diseased plants.

Raspberry Beta Leaf Curl Luteovirus

Infecting blackcaps, especially Cumberland, but also causing severe curling on Cuthbert and hybrid purple Columbian.

Raspberry Decline

On red raspberry.

Raspberry (Red) Mosaic

Green Mottle; Mild Mosaic; Yellows. Widespread on red and black raspberries, dewberry and blackberry. Symptoms vary greatly, but usually mottled areas are darker green than rest of leaf tissue; there may be blistering and curling downward. On blackcaps, tips are stunted, fruiting laterals shortened, fruit seedy or with poor flavor. Foliation of diseased plants is delayed. Transmission by aphids.

Raspberry (Black) Necrosis

On red and black raspberries and perhaps related to red raspberry mosaic. Leaves are curled down, have necrotic spots.

Raspberry Ringspot Nepovirus

Virus known also as Red Currant Ringspot is transmitted by nematode, *Longidorus* spp. Raspberry cultivars differ in susceptibility.

Raspberry Streak

Eastern Blue Streak, Rosette. On black raspberry. Plants are stunted, smaller in successive seasons, leaves usually curled, close together on canes, dark green, often twisted upside down. New canes have bluish dots or streaks near the base and sometimes on branches of fruiting spurs. Fruit is small, poor; plants are short-lived. Symptoms are less severe in the mild streak strain. Roguing aids in control.

Raspberry Yellow Mosaic = Rubus Yellow Net Bednavirus

Black raspberries are severely dwarfed; fruiting laterals are more upright than normal; foliage is yellow; leaflets are long and narrow. Symptoms show

at high temperatures, while those of red raspberry mosaic are masked. Plants are weakened, die in 2 or 3 years. Transmitted by the raspberry aphid.

Red Clover Vein Mosaic Carlavirus

Caused vein yellowing and mosaic on infected red clover plants.

Rhododendron Necrotic Ringspot Potexvirus

Transmitted by grafting; infected *Rhododendron* spp. showed necrotic rings on leaves.

Rhubarb Chlorotic Ring Spot

Chlorotic spots and rings, necrotic stippling and rings on leaves of rhubarb, reported from Oregon.

Rhubarb Ring Spot

Caused by Turnip Mosaic Potyvirus.

Rhynchosia Golden Mosaic Begomovirus

Reported on soybean in Mexico.

Ribgrass Mosaic Tobamovirus

It is ribgrass strain of Tobacco Mosaic Tobamovirus.

Robinia Brooming

►Locust Witches' Broom.

Rose Mosaic

Infectious Chlorosis. Common on garden roses on the Pacific Coast, sometimes on greenhouse roses in the East and on garden roses originating in the West. Chlorotic areas feather away from midribs of leaflets, often with local distortion, sometimes with ring, oakleaf and watermark patterns. Plants are dwarfed, with buds often bleached, imperfect, on short stems. The virus is carried in understock and infects tops after budding or grafting; no insect vector is known. More than one virus is probably involved. Much rose mosaic seems to be due to the Prunus Necrotic Ring Spot and Apple Mosaic Ilarviruses. Rootstocks can be heat-treated to provide a virus-free source.

Rose Rosette

On species roses, Wyoming, California. Leaflets and flower parts are misshapen, stems dwarfed, with precocious growth of lateral buds, indefinite chlorotic pattern in leaves, increase in thorniness of stems. The general effect resembles 2, 4-D injury. Graft and mite transmissible, but the disease develops slowly.

Rose Streak

On rose in eastern United States. Leaves have brownish or reddish ring and vein-banding patterns; stems have ring patterns and sometimes necrotic areas near inserted buds, causing girdling, wilting of foliage. Transmission is by grafting.

Rose Yellow Mosaic

Chlorotic areas are brighter and lighter yellow than in typical rose mosaic; there is less puckering of leaves.

Saguaro Cactus Carmovirus

Symptomless on Saguaro cactus plants. Virus was found in Arizona but there is no evidence of spread.

Schefflera Ringspot Badnavirus

Bacciliform particles were found in *Brassica actinophylla*.

Shamrock Chlorotic Ringspot Potyvirus

Caused chlorotic Ringspot on leaves and decline of *Oxalis regnellii* plants.

Smithiana Potex Virus

Infected plants are usually symptomless.

Solanum Yellows Luteovirus

Occurs on potato plants.

Sonchus Yellow Net Nucleorhabdovirus

On lettuce.

Sorghum Chlorotic Spot Furovirus

Found only in Kansas; caused chlorotic spot on infected plants.

Sorghum Mosaic Potyvirus

Virus is one of the potyvirus complex infecting tropical grasses.

Sorghum Stunt Mosaic Nucleorhabdovirus

Transmitted by leafhopper, *Graminella sonora*, only in temperatures below 38°C.

Sowbane Mosaic Sobemovirus

Occurred in Europe, South and Central American region; found also in USA.

Sowthistle Yellow Vein Nucleorhabdovirus

Susceptible hosts are *Sonchus oleraceus* and *Lactuca sativa*.

Soybean Dwarf Luteovirus

There are two different strains of this virus; dwarfing strain and leaf yellowing strain. Virions occurred in cytoplasm and cell vacuoles of phloem. Virus transmitted only by aphid vectors in persistent manner.

Soybean Mosaic Potyvirus

Widespread on soybean. Leaves are distorted, narrow, with margins turning down, some with ruffling along main veins; plants are often stunted, pods misshapen with fewer seeds. Transmission by peach, pea and other aphids and in seed. Control by roguing.

Soybean Yellow Mosaic

Soybean Yellow Mosaic is caused by the Bean Yellow Mosaic Virus. Younger leaves show chlorotic mottling, followed by necrotic spots. Soybean bud blight, due to Tobacco Ring Spot Virus, is serious in the Midwest, causing losses up to 100%. Tip buds turn brown, dry brittle; plant is dwarfed, produces no seed.

Sparaxis Mosaic

Strong leaf mottling and crinkling.

Spinach Blight

Caused by Cucumber Mosaic Cucumovirus.

Spinach Latent Ilarvirus

Transmitted by means not involving a vector. Symptoms disappeared soon after infection.

Spinach Yellow Dwarf

In California, confined to spinach, with vein clearing, curvature of midrib; young leaves with mottling, puckering, curling, blisters; old leaves with yellow blotches becoming necrotic. All varieties are equally susceptible. Mechanical transmission and by aphids.

Spring Beauty Latent Bromovirus

Symptomless; best serological test for identification is double diffusion test.

Squash Leaf Curl Bigeminivirus

It is probably the same as Muskmelon Necrotic Mosaic Virus causing severe stunting and leaf curl on plants from family Cucurbitaceae.

Squash Mosaic Comovirus

On squash and muskmelon, mostly in California. Foliage is severely mottled and malformed with dark green blisters. Transmission by banded, western striped and 12-spotted cucumber beetles, but not by pollen.

Squash (Southern) Mosaic

On squash in Florida, infecting also cucumber and watermelon.

Stock Mosaic

On stock, reported from California. Definite mottling with dark green islands conspicuous against light green areas. Plants are stunted; seed pods small; flowers broken with petals undersized. Cut-flower fields are often a total loss, but there are resistant varieties.

Strawberry Crinkle Cytorhabdovirus

Chlorotic and necrotic spotting with crinkled leaves and vein clearing. Transmission by strawberry aphid.

Strawberry Latent Ringspot Nepovirus

Infects strawberry and rose; latent and seedborne in parsley.

Strawberry Latent Virus Rhabdovirus

Causing no distinct symptoms but intensifying those caused by other viruses.

Strawberry Leaf Curl

Caused by Strawberry Veinbanding Caulimovirus plus Strawberry Latent Rhabdovirus.

Strawberry Leaf Roll

Leaflets are rolled down, pale green, small, on spindly petioles.

Strawberry Mild Crinkle

Caused by Strawberry Vein Chlorosis Virus with or without Strawberry Mottle Virus.

Strawberry Mild Yellow Edge Chlorosis Potexvirus

Slight chlorosis of leaf margin.

Strawberry Mild Yellow Edge Luteovirus

Transmitted by aphids in persistent manner. The relation to Soybean Dwarf Luteovirus is so close that they are probably the same species.

Strawberry Mottle

Chlorotic spotting, leaf distortion.

Strawberry Multiplier Disease

Resembling witches' broom and stunt; transmitted by leaf grafting.

Strawberry Necrotic Shock = Tobacco Streak Ilarvirus

Blackish spots on leaves and petioles; whole crown may be killed, but plants recover, and virus becomes latent.

Strawberry Pallidosis = Cucurbit Yellows Crinovirus and Beet Pseudo-Yellows Closterovirus

On strawberry.

Strawberry Pallidosis Virus

Caused no disease symptoms and is transmitted only by grafting; dsRNA was found in infected cells.

Strawberry Phyllody Strawb PhF Phytoplasma

On strawberry.

Strawberry Pseudo Mild Yellow Edge Carlavirus

Symptomless on infected plants; transmitted by aphids in semi-persistent manner. Virus related to Carnation Latent Carlavirus.

Strawberry Severe Crinkle

Due to Strawberry Mottle Virus plus Strawberry Crinkle Cytorhabdovirus.

Strawberry Stunt

In the Pacific Northwest. Plants are erect but short; leaves at first folded, later open, dull with a papery rattle; leaflets cupped or with margins turned down;

midveins tortuous; petioles short; fruits small, hard, seedy. Transmission by the strawberry aphid.

Strawberry Veinbanding Caulimovirus

Diffuse banding along veins; leaflets with epinasty, mild crinkling, wavy margins. Transmission by several aphids, grafting, dodder.

Strawberry Witches' Broom

Leaves are numerous, light in color with spindly petioles; margins of leaflets are bent down; runners are shortened, plants dwarfed; flower stalks spindly and unfruitful. Transmission by the strawberry aphid.

Strawberry Yellow Edge

Central leaves dwarfed, with yellow edges.

Strawberry Yellows

A complex caused by mild yellow edge, crinkle, and mottle viruses. June yellows is a genetic leaf variegation, not due to a virus.
For control of strawberry viruses buy certified plants. Nurseries on the Maryland eastern shore provide 37 varieties virus-free from a foundation stock of indexed plants.

Streptanthera Mosaic

Mottled foliage. Caused by Bean Yellow Mosaic Virus.

Subterranean Clover Red Leaf Luteovirus

Caused mild yellowing, stunting and reddening of many plants from Leguminosae family.

Sugarcane Bacilliform Badnavirus

Occurs in Florida and Hawaii; serologically virus is related only to Banana Streak Badnavirus.

Sunflower Mosaic Potyvirus

Known also as Helianthus Mosaic Virus; caused mild systemic mosaic and mottling, sometimes necrosis on leaves and stems.

Sweet Clover Sweet Latent Nucleorhabdovirus

Virus often together with Bean Common Mosaic Potyvirus caused leaf chlorosis.

Sweet Potato Caulimovirus

There are no conspicuous symptoms on *Ipomoea batata*. There is no evidence of it spreading in the United States.

Sweet Potato Feathery Mottle Potyvirus

First symptom is a yellowing along veins or small diffuse yellow spots. Some leaves are abnormally dark green with feathery yellow areas along veins. Leaves may be slightly rugose and dwarfed. Transmitted by aphids, whiteflies, and sprouts. Caused feathering, clearing and chlorotic spots on *Ipomoea batata* but symptoms usually disappeared soon after infection.

Sweet Potato Internal Cork = Sweetpotato Feathery Mottle Potyvirus

First recognized in South Carolina in 1944, now in most sweetpotato areas, most prevalent in Georgia and the Carolinas. Dark brown to blackish corky spots in flesh of roots, which appear normal outside. Some are present when sweetpotatoes are dug, but cork spots increase in number and size during storage, especially at temperatures higher than the recommended 55° to 60°F. Foliage symptoms are vein feathering and mottling followed by reddish to

purple blotching sometimes in ring form. Quality of Porto Rico variety is severely affected, but not yield. Transmission is by peach and potato aphids and by grafting, with morning-glories used as index plants. Control insects to reduce disease; there is little spread to new plantings 100 yards or more from diseased fields. Cure immediately after digging at 85°F with 90% humidity; then store at 55°F, except seed stocks, which should be kept at 70°F so that lots with internal cork can be selected and discarded.

Sweet Potato Mosaic

Transmitted by fleshy-core and sprout grafts and by sweetpotato whitefly.

Sweet Potato Russet Crack – Strain of Sweetpotato Feathery Mottle Potyvirus

Dark lesions and fine cracks in skin of fleshy roots.

Teasel Mosaic Potyvirus

On Fuller's teasel and scabiosa, with vein-clearing, asymmetry, strong mosaic pattern, malformation, death of plant. Transmission by peach and rose aphids.

Tigridia Mosaic

Pale to yellow-green irregular streaks and blotches in leaves and flower bracts, occasionally dark streaks in flowers. Transmission by lily and melon aphids.

Tobacco Broad Ring Spot

In tobacco, Wisconsin, experimentally to other plants. Chlorotic or necrotic rings, sometimes concentric; young leaves puckered at first.

Tobacco Etch Potyvirus

Mild and severe strains widespread on tobacco, tomato, pepper, petunia, potato and other plants. Symptoms are vein clearing with fine necrotic etching, usually toward base of leaves. Plants are stunted with smaller, mottled leaves. Transmission is by peach, lily, bean and other aphids.

Tobacco Mild Green Mosaic Tobamovirus

Transmitted on the surface of the affected seeds. Infectious virus particles were found in water used for irrigation in greenhouses.

Tobacco Mosaic Tobamovirus

Tomato Mosaic; Pepper Mosaic. General in gardens, fields, greenhouses on tobacco, tomato, pepper, eggplant, petunia, Moraine ash, *Achimenes, Aeschynanthus, Chirita, Codononthe, Episcia*, gloxiana, *Kohleria, Nematanthus, Streptocarpus, Smithantha, Rhoeo*, and nearly all solanaceous plants. Tomato foliage has a light and dark green mottling, accompanied by some curling and malformation of leaflets, often with a fernleaf effect. A yellow strain of the virus causes striking yellow mottling of leaves, sometimes stems and fruits. Yield is greatly reduced. In pepper, yellowish chlorotic lesions are followed by systemic chlorosis. Spinach has some mottling, stunting, necrosis. Eggplant is often killed.

Transmission is by mechanical means – by handling, on tools, through soil, by grafting, possibly but not probably by seed. The virus can be transmitted by feeding of grasshoppers, but apparently there is little spread by the usual aphid vectors. This is the most resistant and highly infectious of all viruses. It withstands heat, even alcohol and various germicides, and retains infectivity in a dried state for many years. The most common source of inoculum is smoking tobacco. Gardeners contaminate their hands by smoking and then infect plants as they transplant, tie, prune, etc., the virus entering through scratches or broken hairs. The first symptoms appear in 8 to 10 days. In greenhouses, even doorknobs, faucets, and flats can be contaminated after handling virus-infected plants and remain a source of infection.

There are many strains of the virus, causing cowpea mosaic, tomato aucuba mosaic, tomato enation mosaic, tomato streak, orchid aucuba, etc.

Control. Remove and burn any suspicious plants in the seedbed along with neighboring plants. Destroy weeds, especially ground cherry and other solanaceous species. Never smoke while working with plants, and always wash hands thoroughly with soap after handling tobacco in any form or touching diseased plants, before handling young seedlings or healthy plants.

Tobacco Necrosis Necrovirus

On tobacco, tomato, aster, geranium and bean, confined to roots, or systemic without symptoms, or systemic with symptoms. In Holland, the virus causes a severe crippling of tulips called Augusta disease, often preventing flowering, resulting in death.

Tobacco Rattle Tobravirus

On Romaine lettuce and transmitted by *Paratrichodorus christiei*.

Tobacco Ring Spot Nepovirus

General on tobacco, petunia, potato, cucumber, celery, Moraine ash and geranium, causing pimple disease of watermelon, bud blight of soy bean, in gladiolus, iris, Astilbe, and Easter lily without symptoms. Causing large chlorotic areas on spinach leaves; faint zigzag lines on beet; pin-point necrotic spots with yellow haloes on cucurbits and fruits first pitted, then with elevated pimples; eggplant yellows, “bouquet disease” of potatoes, with stems curved, shortened, sometimes with black lesions on underside of veins. Petunia seedlings are stunted, first leaves are mottled, and seed pods have few seeds. Mint is stunted.
Transmission is through seed of petunia (but not of tobacco), by nematodes and in some crops by grasshoppers.

Tobacco Streak Ilarvirus

On tobacco, soybean, sweet clover, tomato, common yellow mustard, wild radish, milk thistle, and experimentally a wide range of hosts. Irregular spots, lines, and rings. Distributed worldwide. Virus is known as Asparagus Stunt Virus, Datura Quercina Virus and Strawberry Necrotic Shock Virus. It is

transmitted by thrips, by sap and by seeds. Virus is also transmitted by pollen to the pollinated plants.

Tobacco Vein Mottling Potyvirus

Transmitted by aphids in non-persistent manner. Its natural host plants are Rumex sp., *Nicotiana tabacum* and *Solanum carolinense*. Virus caused chlorotic vein banding symptoms on infected plants.

Tobacco Yellow Net Luteovirus

Spreads by aphids – *Myzus persicae* in California. Virus differs in host range from Beet Yellow Net Luteovirus.

Tomato Aspermy Cucumovirus

Chrysanthemum Aspermy. On tomato the growing point of the main stem is inhibited, axillary shoots giving the plants a bushy appearance; fruit production is curtailed; there may be failure to set seed. The disease was introduced into North America on European and Asiatic varieties of chrysanthemums, which have mottled leaves. Transmission is by foxglove, green peach, and green and black chrysanthemum aphids. Perennial chrysanthemums near tomato fields are a source of infection.

Tomato Big Bud

Leaves curl and hang down; stems are shortened and calyxes greatly enlarged.

Tomato Black Ring Nepovirus

Transmitted by nematodes, seeds and pollen. Virus caused necrotic ringspots, systemic chlorotic ringspots, mottling, stunting and leaf malformation of the following plant genera: *Allium, Apium, Beta, Fraxinus, Lactuca, Lycopersicon, Narcissus, Phaseolus, Robinia, Rubus, Solanum, Tulipa* and *Vitis*.

Tomato Bushy Stunt Tombusvirus

Strains of this virus are known as Carnation Italian Ringspot Tombusvirus, Pelargonium Leaf Curl Tombusvirus and Petunia Asteroid Mosaic Tombusvirus. Virus transmitted by means not involving vectors. Virions were found in all parts of the host plant: in cytoplasm, in nuclei, in nucleoli, in mitochondria and in cell vacuoles. It forms crystals in the cytoplasm.

Tomato Chino La Paz Begomovirus

Found on tomato in Baja California, Mexico.

Tomato Enation Mosaic

Caused by a strain of Tobacco Mosaic Tobamovirus.

Tomato Fernleaf

Shoestring. Caused by Cucumber Mosaic Cucumovirus sometimes with Tobacco Mosaic tobamovirus.

Tomato Infectious Chlorosis Closterovirus

Transmitted by white fly – *Trialeurodes vaporariorum*; caused interveinal yellowing and necrosis in infected tomato plants.

Tomato Mosaic Tobamovirus

Circular, water-soaked necrotic spots on leaves; black streaks on veins; concentric sunken rings on fruit.

Tomato Pseudo Curly Top Hybrigeminivirus

Spreads among tomato plants in Florida. Virus is transmitted by treehopper *Micrutalis malleifer*. Virion genome consists of circular ssDNA.

Tomato Ring Spot Nepovirus

Curling and extensive necrosis of shoot terminals; brown rings and streaks on leaflets, stems, fruits, more pronounced at high temperature. Causes leaf streaks in iris, crumbly fruit of red raspberry and chlorotic spot of geranium. May infect chicory, healall, black medic, moth mullein, impatiens, apple, common cinquefoil and dandelion. Transmission is by dagger nematodes.
Plants that may serve as reservoir plants for Tomato Ringspot Virus are: chickweed, henbit, dandelion, woodsorrel, plantain, strawberry, sorrel and red clover.

Tomato Spotted Wilt Tospovirus

More serious on the Pacific Coast, but also occurring in Florida, Texas and some central and eastern states in greenhouses and sometimes outdoors on plants such as ragwort, purslane, nightshade, desert-rose, and puncture vine. Spotted wilt is common on tomato, potato, tobacco, lettuce, pea, pepper, celery and other vegetables. Ornamentals include amaryllis, aster, begonia, blackberry-lily, calendula, calla, chrysanthemum, dahlia, delphinium, fuchsia, gaillardia, gloxinia, nasturtium, geranium, primrose, petunia, Rieger begonia, hydrangea, stephanotis, salvia, stock, verbena and zinnia.
In tomato there are bronze, ringlike secondary lesions; plants are stunted with some necrosis; there may be a yellowish mosaic with leaf distortion. Fruits are often marked with concentric rings of pale red, yellow, or white. Potatoes have zonate necrotic spots on upper leaves, streaks on stems, which collapse at the top; plants are stunted, with small yield. Lettuce is yellowed, with retarded growth, brown blemishes on central leaves; affected spots are like parchment but with brown margins. Peas have purplish necrotic spots on stems and leaves following mottling, and circular spots and wavy lines on pods. Spots on outer stalks of celery are first yellow, then necrotic with pockets of dead tissue inside petioles; plants are stunted and worthless.
China asters have dead tan areas in leaves, brown surface blotches on stems. Calla lillies have whitish, then brown spots and streaks. On sweet pea, reddish brown to purple streaks may run full length of the stem. Circular to oval leaf spots with diffuse margins are followed by yellowing and death of leaves and stems. Blossoms sometimes develop a circular pattern in the pigment. Delphiniums may have numerous distinct double rings. The viruses

causing oak leaf and ring spot in dahlia are probably strains of the spotted wilt virus.
Transmission is by onion and flower thrips. Only the larvae can become viruliferous by feeding on infected plants, but then there is an incubation period of 5 to 9 days, during which the insect becomes adult, before the virus can be transmitted to healthy plants.

Tomato Streak; Double Streak

Caused by Tobacco Mosaic Tobamovirus plus Potato X Potexvirus. Leaves are mottled green with numerous small, grayish brown papery spots, may wither and dry. Later growth is mottled green and yellow with small chocolate brown spots and dark brown streaks on stems; fruit has brown greasy spots. The disease is more important in greenhouses; workers should refrain from handling tobacco or potatoes while working with tomatoes.

Tomato Top Necrosis Neopvirus

Occurs in Indiana, Missouri and Illinois. Virus is very rare on tomato plantations. It is serologically related to many nepoviruses.

Tomato Western Yellow Blight

► Beet Curly Top Hybrigeminivirus.

Tomato Yellow Leaf Curl Begomovirus

On tomato.

Tomato Yellow Net = Tobacco Yellow Net Luteovirus

Pronounced yellow necrosis of veins and veinlets. Transmission by the peach aphid.

Tomato Yellow Top = Strain of Potato Leafroll Luteovirus

Leaflets small, curled, yellow; or purplish in cool weather.

Tradescantia – Zebrina Potyvirus

Transmitted by aphids to *Tradescantia, Zebrina, Commelina* and *Rhoeo* sp. plants on which it caused mosaics, stuntings and malformation of leaves.

Tritonia Mosaic

Mottling at base of young leaves.

Tulare Apple Mosaic Ilarvirus

Caused leaf chlorosis on *Corylus* and *Malus* sp., it is transmitted only by mechanical inoculation. Virus is related to Citrus Leaf Rugose Ilarvirus.

Tulip Breaking Potyvirus

Due to Lily Latent Mosaic virus often present with Tulip Color-adding virus. Broken tulips appear wherever hybrids are grown. There is little or no obvious effect on foliage and little interference with growth, but there are marked color patterns on the flowers; differences in named broken varieties possibly due to the proportion of color-breaking and color-adding viruses present. Most pure white flowers do not change; some turn pink or red. Pink and bright red flowers have strong color changes; very dark tulips turn even darker. There may be dark stripes due to pigment intensification. Transmission is by aphids, and roguing should take place early, before insects are active. Broken varieties should not be grown near those with solid colors.

Turnip Mosaic Potyvirus

Cabbage Black Ring Spot; Watercress Mottle; Nasturtium Mosaic. On turnip, rutabaga, rape, mustard, cabbage, collard, horse-radish, watercress, garden balsam, nasturtium, stock, lady's slipper, impatien, safflower and sweet rocket. Turnip shows a systemic chlorotic mottling with crinkling, leaf distortion, stunting of plants. Cabbage has numerous small, black necrotic rings or spots; cauliflower and broccoli have a diffuse systematic mottling. Horse-radish has blotchy mottling, necrotic rings, flecks, and streaks on petioles and leaf veins. Variegated flowers appear on nasturtium stock,

wallflower and sweet rocket; the last may be severely crippled or killed. Transmission is by peach and cabbage aphids. Protect seedlings by spraying or screening seedbeds.

Walnut Brooming Disease

Bunch Disease. Presumably virus.

Watermelon Curly Mottle Bigeminivirus

Occurs in Arizona. Infected *Citrullus lanatus* and *Cucumis melo* var. *cantalupensis* plants showed leaf necrosis, vein banding, curling and stunting symptoms.

Watermelon Mosaic Potyvirus

In Florida and probably other states. Symptoms include mild interveinal chlorosis, stunt, distortion, mottle, consisting of green bands along veins or raised green blisters. Leaf apices often form long narrow, sometimes twisted projections, "shoestrings." A yellow strain of the virus causes more yellow spotting with less shoestring effect.

Watermelon Silver Mottle Tospovirus

On watermelon.

Wheat Streak Mosaic Rymovirus

On wild rice (*Zizania*); foliar streak symptoms with chlorotic areas becoming necrotic with eventual leaf death.

White Clover Mosaic Potexvirus

Known also as Clover Mosaic Virus and Pea Wilt Virus, caused systemic mosaics and chlorotic mottlings on clover plants. Virus is transmitted by contact between plants and by seeds.

White Line Mosaic

A mosaic disease of sweet and dent corn with short chlorotic lines along leaf veinal tissue.

Wild Cucumber Mosaic Tymovirus

Occurs in California and Oregon. Virus caused mild leaf chlorosis on natural hosts: *Marah* sp. and *Echinocistis* sp.

Wineberry Latent Virus

Known as Loganberry Calico Virus induced calico disease-like symptoms on blackberry. Virus is transmitted by mechanical inoculation and by grafting but on many *Rubus* sp. remains symptomless.

Wisteria Mosaic

Diffuse yellowish blotches with scattered green islands; mature leaflets twisted.

Wisteria Vein Mosaic Potyvirus

On wisteria.

Yellow Mottle Begomovirus

On okra.

Zucchini Yellow Mosaic Potyvirus

On cucurbits, melon, squash, pumpkin and watermelon.

Zygocactus Montana X Potexvirus

Serologically related to many potexviruses, caused reddening of pads of infected *Zygocactus truncatus* plants. It was found in the USA but there is not evidence of spread.

WHITE RUSTS

White rusts are all members of a single genus, *Albugo*, in the Oomycetes and are apparently obligate parasites like the true rusts. They form a white blister just underneath the epidermis.

Albugo (Cystopus)

Oomycetes, Peronosporales

Sporangia are borne in chains at apex of a short, clavate, usually unbranched sporangiophore, forming a limited sorus beneath the host epidermis and exposed by its rupture. The mycelium is intercellular except for small, knoblike haustoria. The sporangia dry to a white powder and are disseminated by wind, germinating by swarmspores. Fertilization of a globose oogonium and a clavate antheridium produces a single oospore, also germinating by swarmspores.

Albugo bliti. White Rust or White Blister on beet, amaranth, globe amaranth, seabeach amaranth, and smooth pigweed. Blisterlike white pustules formed in leaves change to reddish brown when mature. Flowers and stems are dwarfed, distorted. The fungus winters in seed coats. Destroy infected plants and debris at end of season. Change location of plantings.

Albugo candida. White Rust of crucifers on arugula, cabbage, chinese cabbage, radish, horse-radish, turnip, watercress, garden cress, peppergrass, salsify, mustard, arabis, sweet alyssum, boerhavia, draba, hesperis, candytuft, stock, wallflower and western wallflower.

Blisters appear on any part of the plant except root. They vary in size and shape and are often confluent in extended patches. There seem to be two types of infection: general or systemic, resulting in stunting of entire plant and formation of pustules on all parts; or local, with direct invasion of single leaves, stems, or flowers. Upper surface of leaves often has yellow areas with white pustules on the underside. The latter are powdery when mature, and the epidermis is ruptured to free chains of sporangia that are carried by wind to

moist surfaces. They germinate by 6 to 18 zoospores, swarmspores, which settle down, produce germ tubes, and enter plants through stomata.

Stems have localized or extended swellings, sometimes sharp bends, proliferation from lateral buds giving a bushy growth. Various flower parts are deformed with pronounced distortion of flower pedicels. When these thickened parts die, oospores are formed to survive the winter in crop refuse. The disease flourishes in cool, wet weather; the spores germinate better when slightly chilled.

Control. Remove infected parts of ornamentals as noticed. Clean up all vegetable refuse at end of season and all cruciferous weeds nearby. Spraying is impractical.

Albugo ipomoeae-panduratae. White Rust, general on sweetpotato, also on morning-glory, moonflower, *Jacquemontia* and quamoclit. The disease is usually late on sweetpotato, after vines have made their growth, but it is very conspicuous with irregular yellow areas on upper surfaces and white cheesy pustules on lower surface. Oospores wintering in host tissue are liberated by decay in spring. There are no control measures.

Albugo occidentalis. White Rust of spinach. After a report from Virginia in 1910, the disease went unrecorded until 1937, when it appeared in epidemic form in Texas; it has since been serious in Oklahoma and Arkansas and has attacked all commercial varieties tested at the University of Wisconsin. The white blisters are small, usually on underside of leaves, sometimes on upper. Infected leaves become chlorotic, then brown; the entire crop may be lost.

Albugo platensis. White Rust, on trailing four o'clock, common four o'clock, and boerhavia.

Albugo portulacae. White Rust of portulaca. Swollen and deformed branches bear white pustules. Shoots tend to become more erect and spindling.

Albugo tragopogonis. White Rust of salsify, also on African daisy, antennaria, artemisia, centaurea, feverfew, matricaria, senecio and sunflower. Light yellow areas appear on leaves. The epidermis, forced into domelike swellings, bursts to show chalky sori of spores. Foliage may die; plants are dwarfed. There is no control.

WILT DISEASES

To wilt means to lose freshness or to become flaccid. Wilting in plants may be temporary, due to too rapid transpiration; or it may be permanent, due to continued loss of water beyond the recovery point. Disease organisms, by reducing or inhibiting water conduction, may cause permanent wilting.
Because wilt diseases are systemic, and tied up with the entire vascular system of a plant, they are usually more important, and harder to control, than localized spots or cankers. In many cases the fungus enters the plant from the soil through wounds or root hairs and cannot be controlled by protective spraying. Often, although the fungus is present only near the base of a plant, the first symptom is a flagging or wilting or yellowing of a branch near the top. Many species of *Fusarium* are responsible for important wilts and "yellows." *Verticillium* is a common cause of wilt in maples, other trees, and shrubs, but most important among the wilt pathogens are two species of *Ceratocystis*, one causing oak wilt, the other Dutch elm disease.

Acremonium (Cephalosporium)

► Leaf Spots.

Acremonium diospyri (formerly *Cephalosporium diospyri*). **Persimmon Wilt**, a lethal disease of common persimmon. Wilt appears in scattered localities from North Carolina to Florida and west to Oklahoma and Texas, but most infection is in north central Florida and central Tennessee. Spread is rapid and death quick. First notice of the disease was in Tennessee in 1933. By 1938 only 5% of the persimmons in the infected stand were alive. Topmost branches wilt suddenly, then the rest of the tree, with defoliation and death. The fungus fruits in salmon-colored spore masses in cracks in dead bark of dying trees or under bark of dead rings. Fine, blackish streaks are present in five or six outer rings of trunk, branches, and roots. No control is known.

Cephalosporium diospyri (see *Acremonium diospyri*). **Persimmon Wilt**, a lethal disease of common persimmon.
Cephalosporium sp. **Sunflower wilt**.

Ophiostoma (Ceratocystis)

Ascomycetes, Ophiostomatales

Perithecia enlarged at base, with thin walls, and long slender neck, ascus wall evanescent, ascospores hyaline. Conidial stage may be *Chalara* with endogeneous spores or *Graphium* with external conidia or conidiophores united into a dark stalk (synnema).

Ceratocystis fagacearum (*Chalara quercina, Endoconidiophora fagacearum*). **Oak Wilt**, our most serious disease of oaks, now known in 20 states from Texas and Oklahoma east to Pennsylvania and South Carolina. It has also been reported in Florida. Although apparently present in the Upper Mississippi Valley for many years, the disease did not cause concern, and the fungus was not described until 1943, since when it has become a major threat to our forest economy and to trees in residential areas. All native oak species are susceptible, also chinquapin, chestnut, lithocarpus (and apples in experimental inoculation); but red oaks succumb most rapidly. Scouting for the disease has been done largely by airplane, the discolored foliage being visible up to a half mile.
First symptoms are a slight crinkling and paling of leaves, followed by progressive wilting, bronzing, and browning of leaf blades from margins toward midribs and defoliation progressively downward and inward throughout the tree. Red oaks almost never recover and may be killed within 4 to 8 weeks after symptoms appear. White and burr oaks may persist for some years, with affected branches dying in a staghead effect.
The first internal symptoms are the formation of gums and tyloses in the xylem. After wilting, mycelial mats are formed between the bark and wood, and the bark cracks from the pressure exerted. Perithecia are formed in these mats, which have a sour odor and attract insects. Nitulid beetles, fruit flies, brentids, springtails, bark beetles, and possibly other insects get conidia and ascospores on or in their bodies as they feed, and can inoculate other trees through wounds. We know that ascospores remain viable several months on insects and can be distributed through fecal pellets, but we do not yet know how great a role they play in the spread of oak wilt. Birds have been suspected as carriers but are not yet indicted. Local spread is largely by root grafts,

one tree infecting others within 50 feet and with grafts possible between red and white oaks, not limited to the same species.

Control. In residential areas infected trees should be removed. In forests, felling may wound other trees and spread the disease more than letting the dead tree remain but treated so that it is not infective. Different states handle the problem in different ways. In Pennsylvania, each infected tree is cut, with all other oaks within 50 feet, and ammate crystals are placed on each stump. In North Carolina stumps and felled trees are thoroughly sprayed. In West Virginia the trees are left standing, but a deep girdle into the heartwood dries out the tree so that mycelial mats and spores do not form.

Ceratocystis (Ceratostomella) ulmi (**Graphium ulmi**) (see *Ophiostoma ulmi* and *O. novo-ulmi*). **Dutch Elm Disease**, on American, Sibirian, Slippery and European elms in 31 states, Maine to North Carolina and west to Oklahoma, and on cedar.

Ophiostoma ulmi and **O. novo-ulmi** (formerly *Ceratocystis* (*Ceratostomella*) *ulmi* (*Graphium ulmi*)). **Dutch Elm Disease**, on American, Sibirian, Slippery and European elms in 31 states, Maine to North Carolina and west to Oklahoma, and on cedar. This fatal disease is not really of Dutch origin but is so named because it was first investigated in Holland. It was noticed in Europe about 1918, first in France, then in Belgium and Holland. It spread throughout central and southern Europe, then into England and Wales. In many places it virtually exterminated the elms, including those on the famous avenues at Versailles. It is suspected that the fungus came to Europe from Asia during World War I.

Dutch elm disease was discovered in Ohio in 1930 and in New Jersey in 1933. It has spread north through New England and has become very serious in the Midwest. In 1948, the disease was found in Denver, Colorado, and in 1976 in California. It is now fairly widespread in reports of its occurrence in the United States. The spread of the fungus is linked with the presence of the large and small European bark beetles, *Scolytus scolytus* and *S. multistriatus*. Only the latter is established in this country, having arrived in Boston about 1919. Patient detective work established the fact that the fungus came here in elm burl logs imported for furniture veneer. After one such infected elm burl was found in Baltimore in 1934, months of scouting went on in the vicinity of ports of entry, railroad distributing yards, and veneer plants. Such backtracking showed the infected material had come in at four ports of entry and had been carried by 16 railroads over 13,000 miles in 21 states. From this source the disease got its start in at least 13 areas in 7 states.

Elm nursery stock is, of course, quarantined, and elm burls are embargoed; but who who would have believed that dishes could have anything to do with killing our elms? Dishes have to be crated, however, and several times since 1933 English dishes crated with elm wood carrying bark beetles and *Ceratocystis* have been intercepted. All American and European elms are susceptible. Asiatic elms, *Ulmus parvifolia* and *U. pumila*, are resistant. A seedling elm, named Christine Buisman for its Netherlands' discoverer, is highly resistant, though not immune, and is now available. Other promising seedlings have been tested by the U.S. Department of Agriculture.

Symptoms are apparent from the latter part of May until late fall. The acute form of the disease is characterized by sudden and severe wilting. First the young leaves, then all leaves wilt and wither, sometimes so rapidly that they dry, curl, and fall while still green, before they can turn the usual brown of dead leaves. Sometimes terminal twigs are curled into a shepherd's crook. Chronic disease symptoms are gradual, often taking all summer for complete defoliation. In many cases individual branches or "flags" appear, the yellowed leaves conspicuous against the rest of the tree; but sometimes all leaves gradually turn yellow. In another type of chronic disease, trees leaf out late in spring, with sparse chlorotic foliage and a staghead appearance.

When an affected twig is cut across, the vessels or water-conducting tubes show dark brown or black, being clogged with bladderlike tyloses and brown gummy substances (see Fig. 3.62). The production of these substances is thought to be stimulated by a toxin secreted by the fungus and carried in the sapstream. Symptoms are not dependent on the physical presence of fungal hyphae in all parts of the tree. The fungus lives in the sapwood, fruiting in cracks between wood and loosened bark and in bark beetle galleries under the bark. This fruiting is of the anamorph state, spores being produced in structures called coremia. These are black stalks about 1 mm high with enlarged heads bearing vast numbers of minute, pear-shaped spores embedded in a translucent drop of sticky liquid. Spores in the vessels increase in a yeastlike manner. The perithecial stage, not found in nature, has been produced in culture by crossing plus and minus strains of the fungus.

Although the smaller European elm bark beetle is chiefly responsible for spread of the pathogen, at times the native elm bark beetle, *Hylurgopinus rufipes*, is the agent. When the adult beetles emerge from under the bark of dead or dying trees, they bring along sticky spores on their bodies and deposit them as they feed in the crotches of young twigs or leaf axils of near-

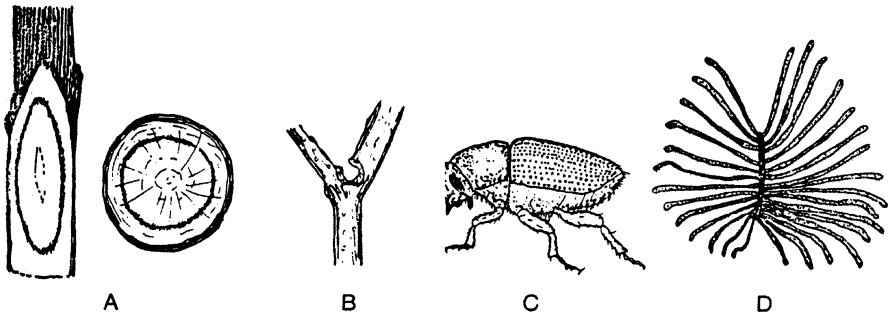

Figure 3.62 Dutch Elm Disease. **A** branch cut to show discoloration of wood; **B** wound in twig crotch due to beetle feeding; **C** bark-beetle carrier of the fungus; **D** egg and larval galleries of the beetle engraved on sapwood

by healthy trees. Although the beetles feed on healthy wood, usually within 200 feet of their original tree, they breed only on weakened or dying wood and may fly some distance for it. The European female tunnels out a brood gallery 1 or 2 inches long in the wood, and when the larvae hatch, they tunnel at right angles across the wood (Fig. 3.62). There is a second brood in August and September, but the overwintering one, emerging in May, is most to be feared. Because the disease often follows traffic routes, automobiles probably account for a good deal of long-distance spread. So far as we know, the only other natural means of infection is by root grafts, made when trees are planted so close together that their roots touch. This is another argument for diversified planting, rather than streets closely lined with but one type of tree.

Control. In the first few frantic years an enormous amount of money (more than $26 million) was spent on trying to eradicate the disease by removing and burning diseased trees; and while this was undoubtedly helpful, it did not stop the spread of wilt. The Federal government has now left the control of Dutch elm disease up to the communities and is restricting its efforts to research. Many towns have taken a laissez-faire attitude, thinking that our elms are doomed anyway, so why waste money? Other, more enlightened communities have proved that a sustained control program keeps the disease down to a negligible 1 or 2%, or less, and that the cost is far, far less than that of continuous removal of dead trees.

The Midwestern Chapter of the National Shade Tree Conference, in its *Guide for Community-Wide Control of Dutch Elm Disease*, suggests:

1. Survey of the total elm tree population to be protected.

2. Symptom scouting for detection of diseased trees and sanitation scouting for badly weakened elms and wood piles containing elm wood.
3. Destruction of known sources of elm wood actually or potentially hazardous for spread of disease. Elm wood piles should be destroyed completely, or each log stripped of bark and the bark destroyed. Diseased trees should be burned, on site if possible, or thoroughly sprayed. Wood chips from diseased elms may still carry the fungus; material should be burned, not used for mulches.
4. Spraying of healthy trees to prevent infection.
5. Maintenance of elms in healthy condition to prevent invasions of bark beetles. This includes proper watering and fertilizing, spraying to control summer foliage pests if necessary.

A single annual DORMANT SPRAY is now considered sufficient to protect healthy elms from bark beetles if enough material is used and complete coverage is obtained. This spray was originally a very heavy dosage of DDT, which caused some bird mortality and other environmental problems. Some communities, of which Greenwich, Connecticut is a good example, figure that they cannot afford not to spray, for it costs less to spray for control than to remove a dead tree. Where dormant spraying and sanitation have been combined consistently, the annual loss from Dutch elm disease has been kept to 1% or less.

Chemotherapy, injection of chemicals that will inactivate the fungus, has been a promising line of research for many years. A parasitic European wasp is now being bred at several laboratories for release against the bark beetles. To have elms in our future we must keep on planting them. Some forms, such as the Christine Buisman and Groeneveld elms, are quite resistant although not immune. Chinese and Siberian elms are resistant.

Dothiorella

► Cankers.

Dothiorella ulmi. **Dothiorella or Cephalosporium Wilt** of elms. **Dieback**, rather common on American elms, occasional on slippery and Siberian elms in central and eastern states. The names are confusing. In culture the fungus develops spores as in *Cephalosporium*, but in nature *Dothiorelia*-type pycnidia are developed on bark of killed twigs. The fungus has also

been classified as *Deuterophoma*. Spores are extruded in a sticky mass and are disseminated by wind, rain, possibly insects. Infection is through insect or other wounds on foliage. The mycelium proceeds from leaf petioles into wood, where it is confined to the vessels. The foliage wilts and yellows; there are gradual dying back of the crown and a brownish discoloration in outer rings of the wood. Without laboratory diagnosis the disease cannot be positively separated from Dutch elm disease, but the elliptical cankers on the stems, with small black specks of pycnidia, provide one diagnostic symptom. Older trees die 3 to several years after first symptoms; nursery trees, in 1 or 2 years. Some trees recover, and some remain infected for many years without showing much effect.

Control. Prune out infected branches a foot or more below the lowest point of discoloration. Promote vigor by feeding, watering, aerating soil. The inclusion of a fungicide in sprays for elm-leaf beetles or cankerworms might be helpful.

Fusarium

► Rots.

Fusarium annuum (*F. solani*). **Fusarium Wilt** of chili pepper. Underground stems are dry, brown, but the roots soft and water-soaked; plants wilt and die rapidly. Spores are spread in irrigation water and with wind-blown particles of soil. Avoid heavy, poorly drained soils.

Fusarium foetens. **Wilt** on begonia.

Fusarium oxysporum. **Wilt** on pyracantha and basil. **Blight and Wilt** on purple coneflower (*Echinacea*).

Fusarium oxysporum f. sp. **apii**. **Celery Wilt**, **Yellows**, general in northern celery districts. There are three strains of the fungus, all causing stunting, vascular discoloration, crown and root rot, but one form causes the entire plant to turn yellow at high temperatures, producing brittle stalks with a bitter taste. Another strain causes downward curling of young heart leaves, and the third produces no above-ground symptoms except stunting. The fungus persists indefinitely in soil. Golden, self-blanching varieties are more susceptible. Grow green petiole celery or somewhat resistant Michigan Golden, Cornell 19, Tall Golden Plume, Golden Pascal or Emerson Pascal.

Fusarium oxysporum f. sp. **asparagi**. **Fusarium Wilt** of asparagus, a major factor in asparagus decline in California, found in most plantings. The fungus lives in soil and may be distributed on seed.

Fusarium oxysporum f. sp. **barbati**. **Fusarium Wilt** of sweet william. New growth is yellowed; plants are stunted; leaves point downward and are tinged with tan as they die. Roots and lower stem are discolored brown. Plant in new or sterilized soil.

Fusarium oxysporum f. sp. **batatas**. ► Rots.

Fusarium oxysporum f. sp. **betae**. **Fusarium Yellows** on sugar beet.

Fusarium oxysporum f. sp. **callistephi**. **Aster Wilt**, one of the most serious diseases of China aster, unless resistant seed is used. Plants wilt, wither, and die at any age from seedlings to full bloom. Older plants are often stunted, with a one-sided development and a brown discoloration of the vascular system. Sometimes all lower leaves are wilted, with blackening at base of stem, often with a pink spore mass at ground level. Plants in full bloom may suddenly droop their heads. Such symptoms are in contrast to the mycoplasma-like disease, aster yellows, where the plant remains upright, although stunted and yellow. The fungus is seed-borne and persists in the soil many years.

Control. Sterilize soil for seedbeds. Some seedsmen provide seed of wilt-resistant varieties, but maintaining resistance means continuous selection from asters grown on heavily infested soil under conditions highly favorable for infection, and this is an expensive process.

Fusarium oxysporum f. sp. **cattleyae**. **Wilt** of cattleya orchids. The fungus was isolated from a private collection in Ohio. Leaves wilted, roots abscised and decayed; flowers fewer, smaller, short-lived.

Fusarium oxysporum f. sp. **chrysanthemi**. **Fusarium Wilt** on chrysanthemums.

Fusarium oxysporum f. sp. **conglutinans**. **Cabbage Yellows**, **Fusarium Wilt**, general on cabbage and other crucifiers, probably the most destructive disease of such hosts in the Midwest, perhaps other sections. It is serious on cabbage, kohlrabi, and collards. Brussels sprouts, cauliflower and broccoli are moderately susceptible in hot dry seasons. The fungus, which can live many years in the soil, enters through the roots, usually right after transplanting or at the first hot weather, with potassium deficiency as well as heat thought to favor infection. The fungus progresses upward in the xylem, not invading other elements until the plant dies.

The most striking symptom is the dull yellow to greenish color of the foliage, together with a warping or curling of basal leaves. Leaves are killed and

shed from the base up; the woody tissue in the stem is brown, with a water-soaked appearance. The fungus is spread by soil clinging to farm implements, drainage, water, wind, animals and infected seedlings. Once the disease is established, general sanitation and crop rotation are of little help against a fungus that can survive so long without a susceptible host.

Control. Once soil is infested resistant varieties offer the only hope. Many have been developed, including Jersey Queen, Marion Market, Wisconsin Golden Acre, Resistant Detroit, resistant strains of Early Jersey Wakefield, Charleston Wakefield, Globe, Wisconsin All Season and Wisconsin Hollander.

Fusarium oxysporum f. sp. **cucumerinum**. **Cucumber Wilt**. A newly recognized form of *Fusarium* highly pathogenic to cucumber and muskmelon in Florida, only slightly pathogenic to watermelon.

Fusarium oxysporum f. sp. **cyclaminis**. **Fusarium Wilt** on cyclamen.

Fusarium oxysporum f. sp. **cubense**. **Wilt** of banana.

Fusarium oxysporum f. sp. **dianthi**. **Carnation Fusarium Wilt**, **Yellows**, **Branch Rot**, general. The first symptom is a slow withering of shoots, often accompanied by change of color from normal deep green to lighter green to pale straw yellow. Plants appear wilted, especially during the warmer part of the day. Only one side of the plant may be affected, resulting in distortion and tendency to curl. If the stem is split, a brownish streak is seen in the vascular system. There may be a dry, shreddy rot of affected wood and cortex. Plants may be infected at any age, but succumb faster if attacked when young. This species of *Fusarium* does not rot roots; see *F. roseum* under Rots for the form causing stem and root rot on carnation.

Control. Sterilize greenhouse soil and benches; take cuttings from healthy mother block; avoid overwatering. Drenching newly flatted or benched plants has reduced the number of wilted plants but does not replace steaming or otherwise sterilizing soil.

Fusarium oxysporum f. sp. **erythroxyli**. **Wilt** of *Erythroxylum*.

Fusarium oxysporum f. sp. **gladioli**. ▸ Rots.

Fusarium oxysporum f. sp. **hebae**. **Fusarium Wilt** of *Hebe buxifolia*, and veronica. Reported as killing nursery plants in California.

Fusarium oxysporum f. sp. **lactucum**. **Wilt** of lettuce.

Fusarium oxysporum f. sp. **lycopersici**. **Fusarium Wilt** of tomato, general, in many sections the most damaging tomato disease in field and greenhouse. Chief losses are in states where air temperatures are rather high during most of the season, susceptible varieties dying or producing little fruit. Losses go

up to 30,000 tons of canning tomatoes, or 10 to 35% of the crop in many states.

In seedlings there is downward curvature of the oldest leaves followed by wilting and death. In older plants the disease is most evident as fruit begins to mature, lower leaves turning yellow, first on one side of the stem or leaflets on one side of the petiole. One shoot may be killed before the rest of the plant shows symptoms.

The fungus enters through roots and grows into the stem, where it produces the toxic substances causing wilting and eventual death. The vascular system in the stem shows a dark brown discoloration. In severe infections the fungus grows into fruit and seeds, but such fruits usually drop, and seed is not used. Almost all original infection comes from the soil, the *Fusarium* operating best in light sandy soils and at temperatures between 80° and 90° F, but the disease is spread widely in transplants. It is encouraged by low potassium and high nitrogen nutrients.

Control. Start seedlings in clean soil; do not grow in the same land more than once in 4 years. The use of resistant varieties is the chief means of control. Marglobe, Pritchard and Rutgers are moderately resistant, but infestation by nematodes may predispose even these to wilt. Pan America, Southland, Homestead and Jefferson are more highly resistant. Treating soil with nematicides may reduce incidence of wilt even though the wilt pathogen is not killed.

Fusarium oxysporum f. sp. **melonis**. **Muskmelon Fusarium Wilt**, similar to that of watermelon, important in Minnesota, New York, New Jersey and Maryland. Seeds rot in soil; seedlings damp-off; vines wilt. Fungus persists in soil and is carried internally in seed. Varieties Golden Gopher and Iroquois are quite resistant.

Fusarium oxysporum f. sp. **niveum**. **Watermelon Wilt**, general on watermelon, also on citron. The fungus is transported in and on seed and persists in soil 15 to 18 years. It rots seeds or seedlings, causes wilting of plant, sometimes with cottony mycelium on surface of dying vines. Resistant varieties include Improved Kleckley Sweet and Klondike.

Fusarium oxysporum f. sp. **perniciosum**. **Mimosa Wilt** on mimosa from New Jersey and Maryland to Florida. This extremely pernicious wilt started about 1930 at Tryon, North Carolina, and mimosas have wilted and died at a rapid rate ever since. The wilt appeared in one city block at Morgantown, North Carolina in 1943, and by 1947 trees were dead and dying on 232 blocks.

The first external symptom is a wilting and yellowing of leaves on some of the branches, causing foliage to hang down, then die and drop. Death of the tree follows from a month to a year after first infection. The trunk has a brown ring of discolored sapwood, usually in the current annual ring, and the color may extend out into the branches. The xylem is plugged with brown gummy substances. Small branches may have a one-sided wilting with the bark flattened over collapsing tissue. The disease has been spreading in Maryland since 1947, in Florida since 1952.

As with other *Fusaria*, this is a soil fungus entering through the roots, and eradication of diseased trees has no effect on spread of the wilt. Nematodes, by their wounds, may increase the incidence of wilt. Out of a great many seedlings grown from seed collected from Maryland to Louisiana, inoculated several times with the fungus and planted in infested soil, some have remained mostly disease-free. These have been propagated by the U.S. Department of Agriculture. Released for commercial sale are Charlotte and Tryon.

Fusarium oxysporum f. sp. **pisi**. **Pea Wilt**, caused by race 1 of this pathogen and **Near Wilt**, caused by race 2. Race 1, confined to pea, produces stunted plants, pale yellow green, with leaves curled downward, stem thickened and brittle near the ground. Plants wilt and die prematurely. The disease may cause more or less circular bare spots in the field, enlarging each year if peas are planted continuously, encouraged by high soil temperature. Some commercial pea varieties are resistant to race 1 but not to race 2. Delwiche Commando was the first variety introduced resistant to both races.

Fusarium oxysporum f. sp. **raphani**. **Radish Wilt**. Young plants turn yellow and die; others are stunted, with discoloration of roots.

Fusarium oxysporum f. sp. **spinaciae**. **Fusarium Wilt** of spinach. Plants are pale; leaves roll inward, gradually die. The wilt is serious in Texas and Virginia. One form of the mosaic-resistant Savoy spinach is also resistant to wilt.

Fusarium oxysporum f. sp. **tracheiphilum**. **Wilt** of cowpea.

Fusarium solani f. sp. **pisi**. **Wilt** of chick-pea.

Hendersonula

Deuteromycetes, Coelomycetes

Pycnidia dark, separate; spores dark with several cells.

Hendersonula toruloidea. **Branch Wilt** of walnut. **Canker**, destructive to Persian walnuts but associated with sunburn of affected branches. The fungus is a wound parasite.

Phialophora

► Rots.

Phialophora gregata. **Wilt** of chick-pea.

Phomopsis

► Blights.

Phomopsis sp. **Wilt** on ice plant.

Phytophthora

► Blights.

Phytophthora cactorum. **Wilt** of blue laceflower and baby's breath.
Phytophthora cinnamomi. **Rhododendron Wilt**. A wilt of young stock, grafted plants 2 to 3 years old, seldom on older shrubs, most severe on *Rhododendron ponticum*. The foliage is first dull yellow, then permanently wilted, roots are decayed; stems are brown at soil level and below. Remove infected stock from frames immediately; avoid excessive irrigation; keep soil acidity at pH 4.0 to 4.5; provide shade and mulch for young plants. This pathogen also causes wilt of Japanese umbrella tree.
See under Rots for this fungus at work on many other plants.

Pythium

► Rots.

Pythium myriotylum. **Wilt** on peanut.
Pythium tracheiphilum. **Wilt** on lettuce and also leaf blight.
Pythium aphanidermatum. **Wilt** of *Nicotiana*.

Rhizoctonia

► Blights.

Rhizoctonia solani. **Wilt** of watermelon.

Sclerotinia

► Blights.

Sclerotinia minor. **Wilt** of lupine and wild garlic.

Verticillium

Deuteromycetes, Coelomycetes

Conidia one-celled, hyaline, globose to ellipsoid, formed at tips of whorled branches and separating readily from tips.

Verticillium albo-atrum. **Verticillium Wilt**, **Maple Wilt** of many ornamental trees, shrubs, fruits, flowers and vegetables. The fungus was first isolated from potatoes in Germany in 1870 but apparently was present in California as early as 1850. It attacks nearly 300 cultivated plants of widely diverse types and may persist as a saprophyte in the soil 15 years or more.

Of the ornamental tree hosts silver maples are most susceptible, then sugar and red maples, elms, with occasional reports on ailanthus, alfalfa, aspen, ash, boxelder, beech, black locust, camphor-tree, carob, catalpa, Chinaberry, cucumber, deerbrush, dogwood, goldenrain, horse-chestnut, India hawthorn, redbud, linden, magnolia, oak, osage-orange, olive, pistachio, persimmon, periwinkle, Russian olive, sassafras, strawberry, smoke-tree, tulip-tree, walnut, mango, sunflower and hickory. Maples may wilt suddenly in midsummer, often a large branch or one side of the tree drying and dying while the other side stays fresh. The sapwood of the infected side has greenish streaks, and sometimes slime flux develops on the bark. The disease can be chronic, progressing slowly for several seasons, or acute, affecting the entire tree in a few weeks. In elms the leaves may be smaller than normal, with a drooping flaccidity in hot hours of the day. Later there is a slight yellowing, deepening until the foliage is a striking lemon yellow. Defoliation starts at time of first yellowing, and quite often branchlets drop as well as leaves. Sapwood

discoloration is brown, and the disease cannot be told positively from Dutch elm disease without laboratory cultures. Tyloses and gums are formed in the wood as with other toxin-producing fungi. The fungus always progresses upward through the xylem vessels so there is little danger of downward infection of the main trunk from pruning operations. Progress is slowed by adequate moisture and by high nitrogen fertilizers, ammonium sulfate being particularly helpful.

Verticillium wilt is also a problem on rose understock. Ragged Robin, Odorata, and Multiflora are very susceptible, Dr. Huey less susceptible, and Manetti resistant.

In fruit trees the wilt is often known as black heart or verticillosis. It is common in apricots, less so in almonds and peaches; branches may drop their leaves and die. Also susceptible are sweet and sour cherry, avocado, plum and prune.

On bush fruits – raspberry, blackberry, dewberry and youngberry – the disease is commonly known as blue stem. The symptoms appear late in the season, leaves turning pale, cane tips bending downward, canes taking on a bluish color, lower leaves wilting and drying. Death is often delayed until the season after first infection. Black raspberries are more susceptible than red. The disease is sometime serious on strawberries, especially in California, but cannot always be separated from root rots. Plants may collapse in large areas at the beginning of hot weather.

Verticillium wilt is very destructive to mint in Michigan and Indiana, also reported, though not so serious in Oregon and Washington. Infected plants

Figure 3.63 Verticillium Wilt on Tomato

are stunted, defoliated, and killed; yield of oil is greatly reduced. The fungus attacks all species of mint, but peppermint is most susceptible. There are some resistant hybrids. Deep plowing, inverting the soil, has reduced the amount of wilt.

Verticillium is especially damaging to tomatoes in Utah and California. First symptoms are yellowing of older leaves and wilting of tips during the day;

Figure 3.64 Verticillium Wilt on Potato

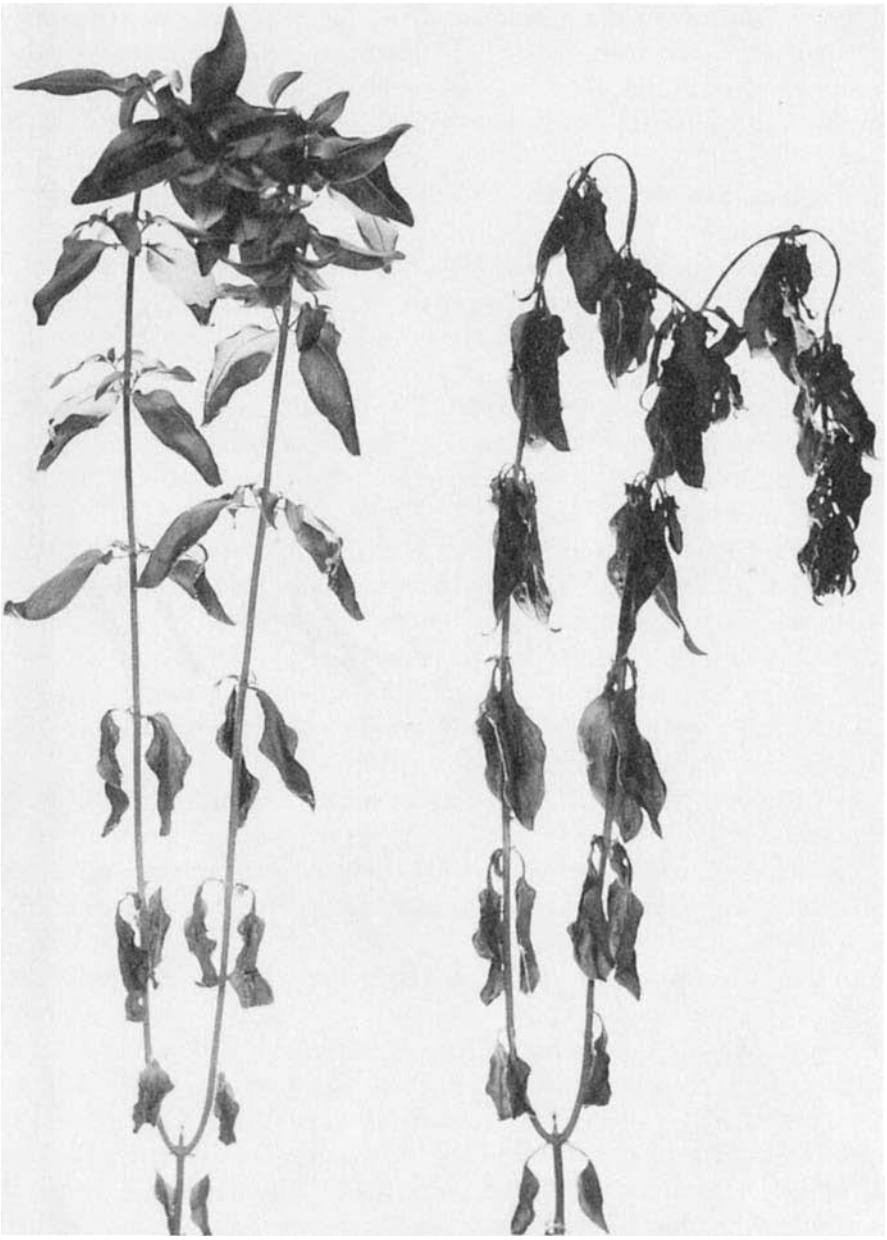

Figure 3.65 Verticillium Wilt on Snapdragon

later, margins of all leaves curl upward, then leaves drop (see Fig. 3.63). Plants are stunted; fruit is small. Moderately resistant varieties Riverside and Essar have been developed for California. Symptoms on potatoes are rather indefinite, but often there is yellowing of lower leaves, shortening of internodes, and rosetting of the top (see Fig. 3.64). Resistant varieties may be symptomless hosts. Verticillium wilt is common on eggplant and okra, rather rare on pepper. It occurs on Chinese yard-long bean, rhubarb and New Zealand spinach.

On herbaceous perennials in eastern gardens I find Verticillium wilt common on aconite and chrysanthemum, with leaves turning dark brown and hanging down along the stem. When the stem is cut across near the base, a circle of black dots indicates the fungus in the vessels. Such plants seldom die immediately but flower poorly and gradually peter out. Wilt was serious on greenhouse chrysanthemums until a wholesale commercial concern started to provide healthy propagating stock from cultured cuttings. Other ornamental hosts include abutilon, aralia, barberry, begonia, China aster, carnation, dahlia, fremontia, geranium, marguerite, peony, poppy, snapdragon (see Fig. 3.65), stock and viburnum.

Control. Sometimes it is possible to prune out an infected maple and still save the tree, but often the dying tree must be taken out. Neither maple nor elm should be replanted in the same spot. Do not transfer plants from areas where wilt has appeared. Do not set raspberries following potatoes or tomatoes; do not use tomatoes after eggplant or potatoes without a long rotation. Proper fertilization and adequate watering may help trees to recover from wilt.

Verticillum dahliae is considered by some a synonym of *V. albo-atrum* and by others as a distinct species; reported as causing wilt of dahlias, mint, marigold, ice plant, barley, wheat, oat, potato, Leucospermum, impatiens, giant hyssop, globe artichoke, ash, cabbage, Cineraria and Echinacea, and other plants. This form has microsclerotia and grows on agar at slightly higher temperatures.

Verticillium fungicola. **Dry Bubble** of oyster mushroom. Infection of sporophores at pin or button stage cause development of typical dry bubbles; mature sporophores show cracking and curling of tissues, and depressed, brown, necrotic areas.

WITCHWEED

A parasitic weed, *Striga asiatica*, new to the western hemisphere, was reported from North Carolina in 1956 and later from South Carolina, although apparently it was first seen in the latter state in 1951 following construction of a power line across a farm. The plant is an obligate root parasite of corn and crabgrass, perhaps other plants. It is 2 to 15 inches high, foliage varying from dark to light green, with linear leaves curving downward, tubular flowers with two-lipped corolla, cardinal red on the upper surface with a yellow eye, straw yellow on the lower surface. The numerous brown seeds are very minute.

Witchweed is reported from other countries on 63 plant species, 56 of them members of the Gramineae (grains and grasses). Tests in the United States with 77 non-gramineous hosts found none parasitized by witchweed, but 45 species of our grasses and grains are susceptible to this new pest. To help in eradication, report suspicious weeds immediately to your county agent or extension pathologist.

Chapter 4
Host Plants and Their Diseases

The information telescoped into this section is taken in large part from the records of the Plant Disease Survey as given in the *Plant Disease Reporter, Plant Diseases* and from the *Index of Plant Diseases in the United States*, Agriculture Handbook 165, U.S. Department of Agriculture. I have added to these recent records as I have run across them in the literature and a few personal observations. Inevitably I have missed some, and there will be many more appearing while this text is in press; so the lists cannot be regarded as complete. There are a great many more records than in the previous editions, but with surveys bringing new reports every day, any such list is out of date by the time it is typed; and by the time it is printed and available, many months later, it is sure to be far from complete. This check list is offered as a helpful guide, a foundation on which to build. It is by no means the last word.

The hosts selected for inclusion in the *Handbook* are those trees, shrubs, vines, flowers, and vegetables likely to be grown in home gardens. Native plants sometimes grown in wild gardens are here, and some forest trees if they are sometimes used as ornamentals. Some plants more often grown for profit are included if they have anyplace around the home. Cereals, cotton, and other strictly field crops are omitted. Hosts are listed alphabetically by common names except where the scientific names mean less confusion. Often there are several common names, and the Latin name is more likely to be generally recognized.

The diseases are those reported from Maine to Florida, from New York to California, and some from Alaska, Canada and Mexico. Tropical diseases are included only as they affect plants in southern Florida. Diseases peculiar

to Puerto Rico, the Canal Zone, and Hawaii are mostly omitted for lack of any personal experience with them, as well as lack of space.

The geographical distribution of diseases can be taken only as a general guide. It is likely that a disease present in New York is also present in neighboring states but has not been officially reported, or that I have missed seeing the report, or that a long list of states would take too much room. Diseases listed as "general" are prevalent throughout the host range; "widespread" means found over a wide area but not prevalent; "occasional" means of infrequent occurrence.

Fungi possibly parasitic that have been recorded as present on leaves or woody plant parts but not as causing a specific disease have been omitted.

Brief comments, following some of the listings, sort out a few of the more important problems, but specific descriptions and control measures are to be found in ►Chap. 3. In that chapter the diseases are grouped according to the names by which they are commonly known, as Rot, Wilt, Blight, Blackspot, and so on, and then by the name of the pathogen, the agent causing the disease. In this Host section, ►Chap. 4, the key word, for example rot or blight, is given in "cap and small caps" (an initial capital followed by small capitals), followed by the name of the pathogen in boldface. In the disease section (►Chap. 3) the pathogens are likewise listed in boldface, but in alphabetical order under each heading such as rot or blight, and then the common name of the disease is given in cap and small caps.

For instance, your acacia seems to be dying, and you think it may have a root rot; perhaps you can see objects like toadstools at the base. You look up ACACIA and check the possibilities until you come to the line: ROT, Mushroom Root. **Armillaria mellea**, occasional; **Clitocybe tabescens**, FL.

"Occasional" means that this rot might be found wherever acacias grow. You live in California so you turn to the section head ►ROTS in ►Chap. 3 and thumb down through the A's until you come to ARMILLARIA. Under the name is the classification of the genus, but you can leave that to the pathologist and go to:

"**Armillaria mellea**; MUSHROOM ROOT ROT of trees and shrubs, also known as Armillaria root rot or toadstool disease." You learn that this disease is especially common in California, and that the honey-colored mushrooms or toadstools are not always present for diagnosis but that black shoestrings are also telltale charac ters. You conclude that this is your fungus, and you read on to see what can be done to the soil to prevent a recurrence of the problem. But before you do anything too drastic, you should discuss the

whole situation with someone at the University of California, for you could be mistaken.

It cannot be expected that a gardener can make accurate diagnosis of disease from reading this *Handbook* any more than reading a medical book can turn a layperson into a doctor. It takes years of experience to recognize diseases on sight, from macroscopic symptoms, and it takes some technical training to recognize diseases by studying the fungus under the microscope and perhaps growing it in culture. For airtight identification of a bacterium or fungus with a new disease the organism must be repeatedly isolated in culture; the disease must be produced in healthy plants by inoculating them with a pure culture of the organism; and then the fungus, or bacterium, must be reisolated from the artificially infected plant.

In some cases the small number of known diseases for a plant together with their distinctive type and geographical distribution makes layperson identification relatively reliable. In other cases, specific identification, other than to know that it is a leaf spot, is unnecessary. And in still other cases, specimens should be sent to your state experiment station for diagnosis. It is my hope that the overburdened extension pathologist, receiving some unusual specimen, will find this list of host plants and their diseases of value in speeding up identifications.

HOST PLANTS

Headings Under Which Diseases Are Described

ANTHRACNOSE – dead spots with definite margins, often with pinkish slimy spore masses, on leaves, stems, or fruit.

BACTERIAL DISEASES – all types of diseases, galls, blights, rots, leaf spots, caused by bacteria.

BLACK KNOT – black, knotty enlargement of woody tissue.

BLACKLEG – darkening at the base of a plant.

BLACK MILDEW – superficial dark growth caused by parasitic fungi.

BLACKSPOT – a dark leaf spot on rose.

BLIGHTS – general killing of leaves, flowers, stems.

BLOTCH DISEASES – irregular necrotic areas on leaves or fruit.

BROOMRAPES – leafless herbs parasitic on roots.

CANKERS AND DIEBACK – localized lesions on stems or trunks, sometimes accompanied by dying back from the top.

CLUB ROOT – distorted swollen roots.

DAMPING-OFF – sudden wilting of seedlings or rotting of seeds in soil.

DODDER – parasitic seed plant with orange tendrils.

DOWNY MILDEWS – with internal mycelium but fruiting structures protruding to form white, gray, or violet patches.

FAIRY RINGS – mushrooms growing in circles.

FRUIT SPOTS – blemishes on fruit.

GALLS – noticeable enlargements of leaves, stems, or roots.

LEAF BLISTER, LEAF CURL DISEASES – leaf deformities.

LEAF SCORCH – discoloration as if by intense heat.

LEAF SPOTS – delimited dead areas in leaves.

LICHENS – occasional on trees, or shrubs.

MISTLETOE – semiparasitic seed plant, forming leafy tufts in trees.

MOLDS – conspicuous fungus growth on leaves, seeds, or grafts.

NEEDLE CASTS – conspicuous shedding of evergreen foliage.

NEMATODES – causing decline diseases.

NONPARASITIC DISEASES – due to environmental conditions rather than specific organisms.
POWDERY MILDEWS – superficial white felty or powdery growth on leaves and flowers.
ROTS – soft or hard decay or disintegration of plant tissues.
RUSTS – with reddish or rust-colored spore masses.
SCAB – raised or crustlike lesions on leaves or fruit.
SCURF – flaky or scaly lesions.
SLIME MOLDS – found in lawns.
SMUTS – with sooty black spore masses.
SNOWMOLD – light patches in turf, especially early spring.
SOOTY MOLD – superficial black mycelium growing in insect exudate.
SPOT ANTHRACNOSE – light spots with raised darker borders or scabby lesion caused by *Elsinoë* species.
VIRUS DISEASES – mosaics, ring spots, yellows, wilt caused by viruses.
WHITE RUSTS – white blisters in leaves.
WILTS – systemic diseases, with wilting, death of leaves, and branches.
WITCHWEED – weed parasitic on roots.
The numbers given with the rusts refer to spore stages. See under RUSTS.

ABELIA

LEAF SPOT. **Cercospora abeliae**, IL.
NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. hapla**; **M. incognita**.
NONPARASITIC. **Chlorosis**, due to soil alkalinity, TX.
POWDERY MILDEW. **Oidium** sp., TX.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX; **Pythium** sp.
VIRUS. **Abelia Latent**, MD.

ABUTILON (Flowering Maple, Indian Mallow, Velvet Leaf)

BLIGHT, Foliage. **Colletotrichum coccodes**, VT.
BLIGHT, Phytophthora. **Phytophthora capsici**, IL.
LEAF SPOT. **Alternaria** sp., IL, IN, NJ, NY, TX; **Cercospora avicennae**, KS, MO, VA; **Cladosporium herbarum**, KS, NY; **Colletotrichum malvarum**, IA; **Phyllosticta althaeina**, TX.

NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL; **M. incognita**, IN; **M. hapla**.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Armillaria mellea**, CA.
ROT, Stem. **Macrophomina phaseoli**, IL.
RUST. **Puccinia heterospora** (III), FL to AZ.
VIRUS. **Abutilon Infectious Variegation**; **Abutilon Yellows**, CA; **Bean Golden Mosaic**, HI; **Mosaic**, universal.
WILT. **Verticillium albo-atrum**, NJ; **V. dahliae**, WI.
The leaf spots and rot occur on Indian mallow and velvet leaf. Variegation in flowering maple is a true mosaic disease, although fostered as a desirable ornamental quality.

ACACIA

CANKER, Twig and Branch. **Nectria ditissima**, CA, SC.
LEAF SPOT. **Physalospora fusca**, FL; **Cercospora** sp., GA; **Phyllachora texana**, TX.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL.
MISTLETOE. **Phoradendron californicum**, CA, TX; **P. serotinum** (**flavescens**), TX.
NEMATODE, Root Knot. **Meloidogyne** sp.
NONPARASITIC. **Chlorosis**, due to excess lime, CA; **Gummosis**, due to deficient or irregular moisture, CA.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Heartwood. **Ganoderma applanatum**, CA.
ROT, Mushroom Root. **Armillaria mellea**, occasional; **Clitocybe tabescens**, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Sapwood. **Schizophyllum commune**, CA.
RUST. **Ravenelia australis**, TX; **R. gooddingii**, AZ; **R. hieronymi**, witches' broom, TX; **R. igualica**, TX; **R. roemerianae**, TX; **R. siliquae**, NM, TX; **R. subtortuosae**, witches' broom, TX; **R. thornberiana**, witches' broom, AZ, TX; **R. versatilis**, AZ, CA, NM, TX.

ACACIA (Koa Tree)

LEAF SPOT, Brown; Dark Blight. **Calonectria colhounii**, HI.

ACALYPHA (Copper-Leaf)

DOWNY MILDEW. **Plasmopara acalyphae**, WI.
GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Cercospora acalyphae**, NY to AL, OK, TX, WI; **Phyllosticta** sp., NJ; **Ramularia acalyphae**, TX.
NEMATODE, Lesion. **Pratylenchus** sp., FL.
NEMATODE, Root Knot. **Meloidogyne** sp., GA, MD; **M. incognita**, IN.
POWDERY MILDEW. **Golovinomyces cichoracearum**, WI.
ROT, Mushroom Root. **Clitocybe tabescens**, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, IL.

ACANTHUS

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.

ACANTHOPANAX (Five-Leaf Aralia)

LEAF SPOT. **Alternaria** sp., MO.
ROT, Root. **Phymatotrichum omnivorum**, TX.

ACHIMENES

VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

ACROPTILON REPENS (Knapweed, Russian)

LEAF SPOT. **Cercosporella acroptili**, MT.

ACTINOMERIS (Yellow Ironweed)

LEAF SPOT. **Cercospora anomala**, IA; **Gloeosporium** sp., WV.
POWDERY MILDEW. **Golovinomyces cichoracearum**, PA to VA, KS.

RUST. **Puccinia verbesinae** (0, I, II, III), ME, MD, TN.
VIRUS. **Tobacco Ring Spot**, VA.

ADOXA (Musk-Root)

GALL, Leaf. **Synchytrium anomalum**, IA.
LEAF SPOT. **Phyllosticta adoxae**, CO.
RUST. **Puccinia adoxae** (III), CO, UT, WY; **P. argentata** (0, I), IA, MN, WI. II, III on impatiens.

AEGOPODIUM (Bishop's Weed)

VIRUS. **Tomato Spotted Wilt**, PA.

AESCHYNOMENE (Northern Joint-Vetch)

CANKER, Stem. **Diaporthe phaseolorum** var. **caulivora**, LA.

AESEHYNANTHUS

VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

AFRICAN DAISY (*Arctotis*) (*Gerbera jamesonii*)

LEAF SPOT, Blotch. **Cercospora** sp., FL.
NECROSIS, Leaf, Crown. **Sclerotinia sclerotiorum**, AZ.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Crown and Stem. **Whetzelinia sclerotiorum**, CA; **Sclerotinia sclerotiorum**, LA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Root, Crown, and Stem. **Phytophthora cryptogea**, CA.
VIRUS. **Tomato Spotted Wilt**. **Impatiens Serotype**, GA.
WHITE RUST. **Albugo tragopogonis**, NC.

AFRICAN VIOLET (*Saintpaulia*)

BACTERIAL Leaf Blight. **Pseudomonas** sp., OR.
BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan.
NEMATODE, Leaf. **Aphelenchoides ritzemabosi**; Lesion, **Pratylenchus** sp., MD, NJ, OH.
NEMATODE, Root Knot. **Meloidogyne arenaria**, general.
NEMATODE, Spiral. **Scutellonema brachyurus**, MD.
NONPARASITIC. **Ring Spot**, due to wetting foliage with cold water, general; **Petiole Rot**, from touching rim of salt-encrusted pot.
POWDERY MILDEW. **Oidium** sp., occasional in greenhouses.
ROT, Root. **Rhizoctonia solani**; **Fusarium solani**, MD, NY; **Cylindrocarpon radicicola**, MD, NY.
ROT, Root and Crown. **Pythium ultimum**, CA, probably general; **Phytophthora** sp., MD, NC.
Bright yellow ring patterns appear if there is too steep a temperature gradient between leaf and water. Yellowing may be due to excessive bright sunlight. Non-flowering may be due to improper light. Root-knot nematodes as well as mites causes thickened, blistered leaves.

AGAPANTHUS (African-Lily)

BACTERIAL Leaf Streak (water-soaked). **Xanthomonas axonopodis**, FL.
VIRUS. **Ornithogalum Mosaic**.

AGASTACHE (Giant-Hyssop)

DOWNY MILDEW. **Peronospora lophanthi**, IL, IA, WI.
LEAF SPOT. **Ramularia lophanthi**, CA, MT; **Septoria lophanthi**, IL, MO, OH, WI.
LEAF SPOT; Stem Spot. **Ascochyta lophanthi**, IL, IA, WI.
POWDERY MILDEW. **Sphaerotheca macularis** (*S. humuli*), MO, UT, WA, WI.
RUST. **Puccinia hyssopi** (III), NY to IA, MO, WI.
VIRUS. **Mosaic**. Unidentified, IN.
WILT. **Verticillium dahliae**, IA.

AGERATUM

BLIGHT, Southern. **Sclerotium rolfsii**, NJ, NC, probably widespread.
POWDERY MILDEW. **Golovinomyces cichoracearum**, MD.
ROT, Root. **Pythium mamillatum**, CA.
ROT, Root and Stem. **Rhizoctonia solani**, IL, NJ, NM.
RUST. **Puccinia conoclinii** (II, III), GA, MS, NC; 0, I unknown.
STEM ROT. **Alternaria zinniae**, IL.
VIRUS. **Bidens Mottle**, FL; **Tomato Spotted Wilt-lettuce serotype**, GA.

AGRIMONY (*Agrimonia*)

BLIGHT, Stem. **Phoma herbarum**, TX.
DOWNY MILDEW. **Peronospora potentillae**, IA, NY, WI.
LEAF SPOT. **Cercospora** sp., IL; **Phyllosticta decidua**, NC, WI; **Septoria agrimoniae**, IL, IN, IA, MO, NY, NC, TX, WI; **S. agrimoniae-eupatoriae**, IA.
POWDERY MILDEW. **Sphaerotheca macularis**, MA, NE, NC, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia agrimoniae** (II, III), MO; 0, I unknown.
RUST. **Pucciniastrum agrimoniae** (II, III), general ME to FL, NM, ND; 0, I unknown.
VIRUS. **Mosaic**. Unidentified, NY.

AILANTHUS (Tree-of-Heaven)

BLACK MILDEW. **Dimerosporium robiniae**, DC.
BLIGHT, Twig. **Gibberella baccata** (*Fusarium lateritium*), VA; **Diplodia ailanthi**, TX; **D. natalensis**, TX; **Phoma ailanthi**, TX.
CANKER; DIEBACK. **Nectria cinnabarina**, KS, NJ, SC; **N. coccinea**, occasional; **Physalospora obtusa**, KS, MI, NY.
LEAF SPOT. **Cercospora glandulosa**, widespread; **Gloeosporium ailanthi**, LA, TX, WV; **Phyllosticta ailanthi**, VA; **Cristulariella pyramidalis**, FL.
ROT, Butt. **Daedalea unicolor**, occasional.
ROT, Root. **Armillaria mellea**, Northeast; **Phymatotrichum omnivorum**, TX.

ROT, Wound. **Polyporus lacteus**; **P. versicolor**, occasional in living trees; **Schizophyllum commune**.

WILT. **Verticillium albo-atrum**, NY, PA, VA.

Ailanthus is well adapted to city smoke and not often troubled by disease except for wilt, which can be serious and has killed many trees in the Philadelphia area.

AKEE TREE (*Blighia sapida*)

WILT; DIEBACK. **Verticillium dahliae**, FL.

ALDER (*Alnus*)

BACTERIAL Leaf Blight. **Xanthomonas campestris**, CA.

BLIGHT, Gray Mold. **Botrytis cinerea**, WA.

CANKER, Brown Felt. **Septobasidium filiforme**, NC; **S. peckii**, NY.

CANKER; DIEBACK. **Nectria coccinea**, NY, PA; **N. galligena**, NH; **Hymenochaete agglutinans**, MI, NY, PA; **Melanconis alni**, ME to NJ, WI; **Phomopsis alnea**, KY; **Physalospora obtusa**, SC, VA; **Solenia ochracea**, widespread on bark; **Didymosphaeria oregonensis**, ID, OR, WA.

CANKER, Stem. **Cytospora** sp., OR.

DODDER. **Cuscuta compacta**, MD, VA.

GALL, Root. Cause unknown.

LEAF BLISTER, Catkin Hypertrophy. **Taphrina robinsoniana**, widespread; **T. japonica**, AK, CA, OR; **T. occidentalis**, CA, ID, MT, OR, WA.

LEAF SPOT. **Cercospora alni**, WI; **Cercosporella alni**, AK, OR, WA; **Dothidella alni**, black spot; **Gloeosporium tubiformis**; **Cylindrosporium vermiforme**, WI; **Ophiodothis alnea**, tar spot, NH, PA; **Phyllosticta alnea**, AK; **Septogloeum variegatum**, CA; **Septoria alni**, AK, CA, NY, WA, WI, OR; **Hypospila californica**, CA.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, NM; **P. villosum**, CA; **Viscum album**, CA; on *Alnus rubra* (Red Alder).

MISTLETOE, European. **Viscum album**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp.

POWDERY MILDEW. **Erysiphe aggregata**, ME to NJ, CA, MN, WA; **Phyllactinia corylea**, ME to WI, AL, SC; **Microsphaera alni**, widespread.

ROT, Heart. **Daedalea unicolor**; **Fomes igniarius**; **F. pinicola**; **Ganoderma applanatum**; **Polyporus sulphureus**.

ROT, Root. **Armillaria mellea**, CA; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Daedalea confragosa**; **Daldinia occidentalis**; **Fomes scutellatus**; **Lenzites saepiaria**; **L. trabea**; **Pholiota adiposa**; **Pleurotus serotinus**; **Polyporus adustus**; **P. hirsutus**; **P. versicolor**; **Schizophyllum commune**; **Steccherinum ochraceum**; **Stereum** spp., mostly on dead wood.

RUST. **Melamsoridium alni** (II, III), CA, TX.

SOOTY MOLD. **Scorias spongiosa**, NY to NC, WV.

ALLAMANDA

NEMATODE, Burrowing. **Radopholus similis**, FL.

NONPARASITIC. **Chlorosis**, magnesium deficiency in overlimed or acid soil, FL.

ALLIARIA (Garlic Mustard)

ROT, Root. **Fusarium solani**, IL.

VIRUS. **Cucumber Mosaic**, OH.

ALLIONIA (Trailing Four-O'Clock)

DOWNY MILDEW. **Peronospora oxybaphi**, KS, SD.

LEAF SPOT. **Ascochyta oxybaphi**, IA, WI; **Cercospora oxybaphi**, IA, KS, WI.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia aristidae**, AZ, NM, TX.

WHITE RUST. **Albugo platensis**, AZ, NM, TN, TX.

ALLSPICE (*Pimenta*)

RUST. **Puccinia psidii**, FL.

ALMOND (*Prunus amygdalus*)

ANTHRACNOSE. **Colletotrichum acutatum**, CA.
ANTHRACNOSE; Kernel Rot. **Gloeosporium amygdalinum**, CA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, AL, AZ, CA, NC.
BACTERIAL Leaf Spot. **Xanthomonas pruni**, NE.
BACTERIAL Shoot Blight; Blast. **Pseudomonas syringae**, CA.
BLIGHT, Blossom; Brown Rot. **Monilinia laxa**, CA, OR; **Botrytis cinerea**.
BLIGHT, Leaf; Shot-Hole Disease. **Coryneum carpophilum**, CA, ID, OR.
CANKER; DIEBACK; Crown Rot. **Phytophthora cactorum**, CA, **P. citrophthora**, CA; **Botryosphaeria dothidea** (Dothiorella canker) CA; **Ceratocystis fimbriata**, CA.
CANKER, Pruning Wound. **Phytophthora syringae**, CA.
DECLINE, Almond. Unknown etiology, CA. "Golden Death".
LEAF SPOT. **Cercospora circumscissa**, CA, OR; **Hendersonia rubi**, CA; **Alternaria alternata**, CA; **A. arborescens**, CA; **A. tenuissima**, CA.
NEMATODE, Lesion. **Pratylenchus vulnus**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., AZ.
NONPARASITIC. **Bud Failure**. Seed transmitted, increased by pruning.
NONPARASITIC. **Chlorosis**. Iron deficiency. **Little Leaf**. Zinc deficiency.
POWDERY MILDEW. **Podosphaera tridactyla**, CA; **Sphaerotheca pannosa**, CA.
ROT, Fruit. **Phomopsis amygdali**, CA, and associated branch dieback.
ROT, Green Fruit. **Sclerotinia sclerotiorum**, CA.
ROT, Heart. **Polyporus versicolor**, OR.
ROT, Hull. **Rhizopus** spp.
ROT, Root. **Armillaria mellea**, CA, NC; **Phymatotrichum omnivorum**, TX.
ROT, Wound. **Schizophyllum commune**, CA.
RUST. **Tranzschelia discolor** (II, III); 0, I on anemone, CA.
SCAB. **Cladosporium carpophilum**, CA, CT, OR.
VIRUS. **Almond Bud Failure**; **Almond Calico**, CA: **Peach Mosaic**; **Peach Ring Spot**; **Peach Rosette**; **Peach Yellow Bud Mosaic**; **Peach Yellows**.
WILT. **Verticillium albo-atrum**, CA, IL.

Crown rot and Armillaria rot are often limiting factors in almond production. At least five sprays are necessary to control brown rot, leaf blights, and scab, and often a zinc sulfate spray for little leaf. The California Agricultural

Experiment Station Extension Service provides, each year, a revised "Spray, Dust and Fumigation Program for Almonds".

ALMOND, FLOWERING (*Prunus triloba*)

BACTERIAL Fire Blight. **Erwinia amylovora**, IN.
BACTERIAL Spot. **Xanthomonas pruni**, NJ.
BLIGHT, Blossom and Twig. **Botrytis cinerea**, NY; **Monilinia fructicola**, CT, KS.
POWDERY MILDEW. **Podosphaera oxyacanthae**, IA.
ROT, Mushroom Root. **Armillaria mellea**, MS; White Root, **Corticium galactinum**, MD.

ALOE

ROT, Root. **Pythium ultimum**, CA.
Immerse nursery plants of *Aloe variegata* in hot water at 115°F for 30 minutes; place in cold water; dry; replant.

ALSTROEMERIA

VIRUS. **Alstroemeria Mosaic**; **Alstroemeria**, **NY**.

ALTERNANTHERA

LEAF SPOT, **Phyllosticta amaranthi**, NJ.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Root. **Rhizoctonia solani**, NJ.
ROT, Root; Wilt. **Fusarium oxysporum**, NJ.
VIRUS. Alternanthera Mosaic, FL.

ALYSSUM (Goldentuft, Yellowtuft)

CLUB ROOT. **Plasmodiophora brassicae**, NJ.
DAMPING-OFF. **Rhizoctonia solani**, NJ.

AMARANTHUS (Love-Lies-Bleeding, Princes-Feather, Joseph-Coat, Spiny Amaranth)

BACTERIAL, MLO. **Aster Yellows**, MD, NY.
CANKER, Stem. **Diaporthe phaseolorum** var. **caulivora**, LA.
DAMPING-OFF. **Pythium debaryanum**, CT.
LEAF SPOT. **Cercospora canescens**, MD.
NEMATODE, Root Knot. **Meloidogyne** sp., FL, MD.
ROT, Stem. **Macrophomina phaseolina**, AZ.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Beet Curly Top**, CA, TX; **Alfalfa Mosaic**, WA.
WHITE RUST. **Albugo bliti**, MA to FL, NE, SC, TX.

AMARYLLIS (includes *Hippeastrum*)

BLIGHT, Gray Mold; Bulb Rot. **Botrytis cinerea**, occasional, chiefly in outdoor plantings after chilling.
BLIGHT, Southern; Bulb Rot. **Sclerotium rolfsii**, FL, TX.
LEAF SCORCH; Red Blotch. **Stagonospora curtisii**, general.
LEAF SPOT. **Cercospora amaryllidis**, AL, LA; **Colletotrichum crassipes**; **Fusarium bulbigenum**; **Melanospora fallax**; **Epicoccum purpurascens**, secondary.
NEMATODE, Lesion. **Pratylenchus scribneri**, FL. **Scutellonema brachyurus**, FL.
ROT, Bulb. **Rhizopus stolonifer**.
ROT, Seedling Root. **Pythium debaryanum**, FL, TX; Root, **Armillaria mellea**, CA.
VIRUS. **Cucumber Mosaic**, FL; unidentified **Mosaic**, CA, FL, OK, WI; **Tomato Spotted Wilt**, CA, TX; **Hippeastrum Mosaic**.
Although amaryllis is subject to red spotting from various physiological causes, mite, and insect injuries, the fungus leaf scorch or red blotch is fairly common, with red spots on leaves, flower stalks, and bulb scales.

AMARYLLIS, WILD (*Nothoscordum bivalve*; *N. inodorum*)

VIRUS. **Nothoscordum Mosaic**, LA.

AMELANCHIER (Serviceberry, Juneberry)

BACTERIAL Fire Blight. **Erwinia amylovora**, widespread.

BLACK MILDEW; Witches Broom. **Apiosporina collinsii**, widespread.

BLIGHT, Leaf. **Fabraea maculata**, widespread.

BLIGHT, Fruit and Leaf. **Monilinia gregaria**, CO, IA, WA.

CANKER. **Nectria cinnabarina**, occasional; **Pezicula pruinosa**, widespread; **Gloeosporium perennans**, OR.

CANKER, Blister. **Nummularia discreta**, IA, KS, MA, OH.

LEAF BLISTER; Witches' Broom. **Taphrina amelanchieri**, CA.

LEAF SPOT. **Coccomyces tumidus**, MO, MT; **Cristulariella pyramidalis**, NC; **Phyllosticta innumerabilis**, IA, MN, NE, ND; **P. paupercula**, KS, MT; **P. virginiana**, NY, PA, WI.

POWDERY MILDEW. **Erysiphe polygoni**, ID, MT; **Phyllactinia corylea**, OR, WA; **Podosphaera oxyacanthae**, occasional.

ROT, Brown; Fruit. **Monilinia amelanchieris**, NY; **M. fructicola**, MI, OH.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Wood Butt. **Daedalea unicolor**, cosmopolitan.

RUST. **Gymnosporangium biseptatum** (I); III on *Chamaecyparis*, northeastern and Middle Atlantic States. Horned galls, underside leaves. **G. clavariiforme** (I) on leaves, fruits, stems; III on juniper. **G. clavipes** (I) on fruits, stems; III on juniper. **G. corniculans** (I); III on juniper. **G. cupressi** (0, I); III on cypress. **G. gracile** (0, I); III on juniper. **G. harknessianum** (I) on fruits, CA, OR; III on juniper. **G. inconspicuum** (I) on fruits; III on juniper. **G. juvenescens** (I); III on juniper, in West (may be **G. nidusavis**). **G. kernianum** (I) on leaves, AZ, CO, OR; III on juniper. **G. libocedri** (I) on leaves, CA, OR; III on juniper. **G. nelsonii** (I) on leaves, fruits; III on juniper. **G. nidusavis** (I) on leaves, fruits, stems; III on juniper, central and eastern states.

AMORPHA (Leadplant, Indigobush)

CANKER, Twig. **Cytospora amorphae**.

LEAF SPOT. **Cylindrosporium passaloroides**, widespread; **Diplodia amorphae**, TX.

POWDERY MILDEW. **Erysiphe polygoni**, IA, MN, WY.

RUST. **Uropyxis amorphae**, general.

AMPELOPSIS (*A. cordata* and other species)

CANKER; DIEBACK. **Nectria cinnabarina**, occasional.
DOWNY MILDEW. **Plasmopara viticola**, NY, WI.
LEAF SPOT. **Cercospora truncata**, LA; **C. vitis**, AL, LA; **Guignardia bidwellii**, widespread; **Linospora psederae**, WV; **Phloeospora ampelopsidis**, WI.
NEMATODE, Dagger. **Xiphinema index**.
POWDERY MILDEW. **Uncinula necator**, widespread.
ROT, Root. **Helicobasidium purpureum**, TX.

AMSONIA

LEAF SPOT. **Mycosphaerella** sp., GA.
RUST. **Coleosporium apocyanaceum** (II, III) on leaves, FL, GA, SC; 0, I on pine. **Puccinia seymouriana** (0, I), MO; II, III on marsh grass.

ANAPHALIS (Pearl Everlasting)

LEAF SPOT. **Septoria margaritaceae**, NY, OR, WI.
RUST. **Uromyces amoenus** (III), CA, ID, MI, MT, OR, WA, WY.

ANCHUSA (Buglos, Alkanet)

DAMPING-OFF. **Rhizoctonia solani**, CT.
LEAF SPOT. **Stemphylium** sp., NY.
RUST. **Puccinia recondita** var. **secalis** (0, I), IN, MI: II, III on rye.
VIRUS. **Mosaic**, unidentified, IN.

ANDROMEDA (Bog-Rosemary)

(▶ Lyonia and ▶ Pieris for shrubs commonly called Andromeda)

BLACK MILDEW. **Asterina clavuligera**, GA, NJ.
GALL; Red Leaf Spot. **Exobasidium vaccinii**, AK, ME, NY, WI.
LEAF SPOT. **Venturia arctostaphyli**, NY.
LEAF SPOT. Tar. **Rhytisma andromedae**, ME to NC, AK, MI, MN.

POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, MA, NJ.
RUST. **Chrysomyxa cassandrae** (II, III); 0, I on pine.

ANEMONE (Cultivated forms, Japanese)

BACTERIA, MLO. **Aster Yellows**, CA.
BLIGHT, Collar Rot. **Botrytis cinerea**, NJ, PA
BLIGHT, Southern. **Sclerotium rolfsii**, CA, MD, MA.
LEAF SPOT. **Gloeosporium** sp., NY; **Phyllosticta anemones**, MD.
NEMATODE, Leaf. **Aphelenchoides fragariae**; **A. ritzemabosi**, CA.
NEMATODE, Root. **Aphelenchus agricola**, CA.
RUST. **Tranzschelia cohaesa** (0, I, II, III), TX; **T. discolor** (0, I), CA, OR; II, III on *Prunus* spp.
VIRUS. **Mosaic**. Unidentified, CA; **Tobacco Rattle**, MN.

ANEMONE (Native Species)

DOWNY MILDEW. **Plasmopara pygmaea**, widespread.
GALL. **Synchytrium anemones**, IA MA, MI, MN, VT, WI.
LEAF SPOT. **Cercospora pulsatillae**, CO; **Cercosporella filiformis**, WI; **Didymaria didyma** IA MI WI; **Phloeospora anemones** IA; **Phyllosticta anemonicola**, IL, MI, ME, NE, VA, WI; **Ramularia ranunculi**, NY, WI; **Septoria anemones**, IL, IA, MS, MO, TX, VT, WI; **S. cylindrica**, MT, VA; **S. punicea**, KS, MA, MI, MS, NE.
POWDERY MILDEW. **Erysiphe polygoni**, IL, IA, IN, MI, MN, NJ, ND, WI.
RUST. **Puccinia anemones-virginianae** (III), ME to MS to NE, ND; **P. gigantispora** (0, I, III), CO, IL, ID, MT, ND, WI, WY; **P. magnusiana** (0, I), NY to KS, ND; II, III on reed grasses; **P. pulsatillae** (III), CO, IA, ND, SD; **P. recondita** (0, I), NY to TX; II, III on grasses; **P. retecta**, AK, CO; **P. vesiculosa**, AK.
RUST. **Tranzschelia cohaesa** (0, I, II, III), TX; **T. pruni-spinosae** (0, I), IA, KS, NE to TX, AL; II, III on *Prunus* spp.; **T. fusca** (0, III), MA to VA, CA, and Northwest; **T. suffusca** (0, III), CO, IA, MT, ND, SD; **T. tucsonensis** (0, I, II, III), AZ.
SMUT, Leaf and Stem. **Urocystis anemones**, ME to AK, DE, CO, KS, IA, MN, ND, WI; **U. sorosporioides**, AK.
SMUT, White. **Entyloma ranunculi**, WI.

ANGELICA

LEAF SPOT. **Cercospora apii** var. **angelicae**, AK; **C. thaspii**, AL, TX; **Fusicladium angelicae**, general; **Gloeosporium angelicae**, SC; **Phyllosticta angelicae**, CA, WY; **Piggotia depressa**, MT; **Ramularia angelicae**, CO; **Septoria dearnessii**, NC, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia angelicae** (0, I, II, III), NY, OR, PA, WA; **P. bistortae**, AK; **P. coelopleuri** (0, I, II, III), AK; **P. ellisii**, CA, ID, NV, OR, WA; **P. ligustici**, CO, WA; **P. poromera**, UT.

ANGELONIA (*Angelonia angustifolia*)

NEMATODE, Root Gall, **Meloidogyne mayaguensis**, FL

ANISE (*Pimpinella anisum*)

LEAF SPOT. **Cercospora malkoffi**, VA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, CA, TX.
RUST. **Puccinia pimpinellae** (0, I, II, III), CA.

ANISE-TREE (*Illicium floridanum*)

BLACK MILDEW. **Lembosia illiciicola**, AL, MS.
LEAF SPOT, Algal; Green Scurf. **Cephaleuros virescens**, LA, SC.
SOOTY MOLD. **Capnodium footii**, MS.

ANODA

NECROSIS, Vascular. **Verticillium dahliae**, NM.
NEMATODE, Cyst. **Meloidogyne hapla**.
POWDERY MILDEW. **Oidium erysipheoides**, NM.
RUST. **Puccinia** sp., TX.

ANTHRISCUS (Chervil)

POWDERY MILDEW. **Erysiphe heraclei**, CA.
ROT, Stem and Crown. **Sclerotinia sclerotiorum**, CA.

ANTHURIUM

BACTERIAL Blight. **Xanthomonas campestris** pv. **dieffenbachiae**, CA, HI; **Ralstonia (Pseudomonas) solanacearum**, FL.
BLACK NOSE (on flower spadix). **Colletotrichum gloeosporioides**.
NEMATODE, Lesion. **Pratylenchus pratensis**, LA.

ANTIDESMA (Chinese-Laurel)

LEAF SPOT, Algal; Green Scurf. **Cephaleuros virescens**, FL.

APHELANDRA (*Zebra plant*)

LEAF SPOT. **Myrothecium roridum**, FL.
NONPARASITIC. **Physiological**. Leaf crinkle, shortened internodes, axillary bud proliferation, TX.
ROT, Stem. **Phytophthora phaseoli**, FL.

APPLE (*Malus sylvestris*)

ANTHRACNOSE, Northwestern; Canker; Fruit Rot. **Neofabraea malicorticis**, prevalent OR, WA, occasional CA, IL, MA, ME, MI, NE, OK.
BACTERIAL Blast, of flowers, shoots. **Pseudomonas syringae**, AR, CA; Blister Spot of bark and fruit. **P. syringae** pv. **papulans**; Rot, **P. melophthora**.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general; Hairy Root, **A. rhizogenes**, Central States, ID, NY.
BACTERIAL Fire Blight. **Erwinia amylovora**, general.
BLIGHT, Limb. **Corticium laetum**, LA, NC; **C. salmonicolor**, FL, LA.
BLIGHT, Southern. **Sclerotium rolfsii**, on seedlings.
BLIGHT, Thread. **Pellicularia koleroga**, WV and IN to Gulf states.

BLOTCH, Fruit; LEAF SPOT; Twig Canker. **Phyllosticta solitaria**, general except New England and the far South.

BLOTCH, Sooty, of fruit. **Gloeodes pomigena**, eastern and central states; **Geastrumia polystigmatis**, NC.

CANKER, Bark; Fruit Rot. **Myxosporium corticola**, New England to MD, IL, MI, OK, OR, SD.

CANKER, Blister. **Nummularia discreta**, east of the Rocky Mts.

CANKER, Bole. **Cylindrocarpon didymium**, WA; **Leucostoma cincta**. WI.

CANKER, Crater. Cause unknown, sunken bark, crown rot, decline. WA.

CANKER; DIEBACK. **Botryosphaeria ribis** (syn. **B. dothidea**, East and South; **Cytospora** spp., widespread; **Fusarium** spp., also Fruit Rot, Pacific Northwest, Secondary to drought, winter injury, insect punctures; **Coryneum foliicola**, widespread; **Glutinium macrosporium**, OR; **Leptosphaeria coniothyrium**, East, central states, WI; **Plenodomus fuscomaculans**, CA, MI; **Sphaeropsis pyriputrescens**, WA.

CANKER, European. **Nectria galligena**, East and central states to NC and MS; Pacific Coast.

CANKER; Leaf Spot. **Monochaetia mali**, IL, NJ to SC, MO, WV; **Leucostoma cincta**, MI.

CANKER, Perennial; Bull's-Eye Fruit Rot. **Neofabraea perennans**, ID, MT, OR, WA.

CANKER; Sapwood Rot. **Hymenochaete agglutinans**, CT; **Hypoxylon** spp.

CANKER, Scurf Bark. **Clasterosporium** sp.

CANKER, Twig. **Coryneum foliicola**, widespread; **Gibberella baccata**; **Nectria cinnabarina**, northern U.S.

DECLINE. **Irpex tulipiferae**, MN; **Coriolus versicolor**, also dieback, MN, WA; **Schizophyllum commune**, MN.

FRUIT SPOT, Black Pox; Canker; Leaf Spot. **Helminthosporium papulosum**, GA, IN, MA, MS, NJ, OH, PA, WV; **Phacidiopycnis washingtonensis** (also Fruit Rot), WA.

FRUIT SPOT, Brooks. **Mycosphaerella pomi**, New England to NC, AR, IA, MO.

FRUIT SPOT, Fly Speck. **Microthyriella rubi**, general.

LEAF SPOT. **Cercospora mali**, Gulf states, VT; **Coniothyrium pyrinum**; **Diaporthe pernisiosa**, AR; **Fabraea maculata**, IA; **Illosporium malifoliorum**, PA to NC, IN; **Mycosphaerella sentina**, IL, NJ, PA; **Pestalo-**

tia spp., MD to NC, ID, IN; Ghost Spot, **Alternaria tenuis**, GA; **Cristulariella pyramidalis**, FL, on *Malus pumila*, **Glomerella cingulata**, TN.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), NC, TX; **Viscum album**, CA.

NEMATODE, Lesion. **Pratylenchus penetrans**; **P. pratensis**.

NEMATODE, Root Knot. **Meloidogyne** spp., MS, TX, UT.

NONPARASITIC. **Bitter Pit**, **Stippen**, **Baldwin Spot**, general in storage.

Black End. Probably drought injury, AL, OR, WA.

Black Heart, of wood. Perhaps freezing injury; widespread.

Brown Core, in MacIntosh variety. Excessive nitrogen, low storage temperature.

Callus Knot. Wound overgrowth from defective union of stock and scion.

Chlorosis. Usually iron deficiency in alkaline western soils.

Collar Rot. Winter injury.

Cork; **Rosette**. Boron deficiency, northeastern states to IN, KY, Pacific Coast.

Internal Bark Necrosis. Cause unknown, possibly same as measles; general.

Jonathan Spot. Associated with dry weather, delayed storage.

Leaf Scorch. Magnesium deficiency.

Measles, reddish pimples in bark. Widespread; cause unknown, possibly boron deficiency in part. False measles due to manganese toxicity.

Ozone Injury. Pitted area in flesh.

Rosette; Little Leaf. Usually zinc deficiency.

Scald. Discoloration of fruit skin by volatile respiratory products, general in storage.Controlled by oiled paper wraps.

Soft Scald and **Soggy Breakdown**. Associated with delayed storage and low temperature.

Stigmonose. Fruit dimpling, distortion from insect punctures; widespread.

Sunburn, of fruit. Heat or light injury.

Sunscald, of bark. Freezing injury of trunk and larger branches on side exposed to sun.

Water-Core. Deficient or irregular water supply.

POWDERY MILDEW. **Podosphaera leucotricha** and **P. oxyacanthae**, general.

ROT, Bitter, of Fruit; Canker. **Glomerella cingulata**, general, especially in South, rare in West; **G. rubicola**, IL; **Colletotrichum acutatum**, AR, MI.

ROT, Black; Frog-Eye Leaf Spot; Canker. **Physalospora obtusa**, general to the Great Plains; **P. mutila**, CA, MT, OR, WA; **P. rhodina**, KY.

ROT, Black Root. **Botryosphaeria obtusa**, PA; **Xylaria mali**, eastern and central states.

ROT, Brown. **Monilinia fructicola**, general except for far South; **M. laxa**, OR, WA.

ROT, Calyx-end. **Alternaria** sp., **Sclerotinia sclerotiorum**, NH, WA.

ROT, Crown. **Phytophthora cactorum**, MA.

ROT, Fruit. **Alternaria mali**; **Aspergillus niger**; **Cephalosporium carpogenum**; **Corticium centrifugum**, Pacific Northwest, occasional in East; **Chaetomella** sp., WA; **Cladosporium** spp.; **Endomyces mali**; **Epicoccum granulatum**, WA; **Gloeosporium** spp.; **Gliocladium viride**, IL; **Hormodendron cladosporiodes**, WA; **Mucor piriformis**, CA, WA; **Oospora** sp.; **Phialophora malorum**, IN, VA, WA; **Pleospora fructicola**, WA; **P. herbarum**, Pacific states; **Penicillium** spp., cosmopolitan; **Phoma** spp.; **Stemphylium congestum**, WA; **Tricothecium roseum**, general; **Botrytis** spp.; **Colletotrichum fructus**; **Rhizopus nigricans**, cosmopolitan; **Phytophthora syringae**, OR.

ROT, Fruit (Post-harvest). **Phomopsis mali**, core rot, CA, NY; **Trichoderma harzianum**, MD; **Sphaeropsis pyriputrescens**, WA.

ROT, Heartwood. **Fomes fomentarius**; **F. igniarius**; **F. pinicola**; **Ganoderma applanatum**.

ROT, Mushroom Root. **Armillaria mellea**, prevalent on Pacific Coast; **Clitocybe tabescens**, AR, FL, TX, VA.

ROT, Postharvest Speck. **Phacidiopycnis washingtonensis**, WA.

ROT, Root. **Botryodiplodia theobromae**, AL; **Hymatotrichum omnivorum**, AK, AZ, NM, TX; **Fusarium oxysporum**, ID; **F. solani**, ID.

ROT, Silverleaf. **Stereum purpureum**, KS, ME, MN, NY, Pacific Northwest.

ROT, White Root. **Corticium galactinum**, DE to VA; AR, IL; **Rosellinia necatrix**, CA.

ROT, Wood. **Daedalea confragosa**; **Poria** spp.; **Pleurotus ulmarius**; **Pholiota adiposa**; **Polyporus** spp.; **Stereum** sp.; **Schizophyllum commune**; **Trametes** spp.

RUSSET, Fruit. **Aureobasidium pullulans** and **Rhodotorula glutinis**, NY.

RUST. **Gymnosporangium libocedri**. (0, I), on leaves, fruit; III on incense cedar, CA, OR; **Gymnosporangium nidus-avis** (0, I), on leaves, fruit, stems, IN, MD, MS, NJ; III on red-cedar.

RUST, Cedar-Apple. **Gymnosporangium juniperi-virginianae** (0, I) on leaves, fruit; general east of Great Plains; III on red-cedar and Rocky Mountain juniper.

RUST, Hawthorn. **Gymnosporangium globosum** (0, I) on leaves; III on red-cedar, ME to AK, KS, NE.

RUST, Quince. **Gymnosporangium clavipes** (0, I), on fruit; III on common juniper and red-cedar.

SCAB. **Venturia inaequalis**, general.

SOOTY MOLD. **Fumago vagans**, occasional.

SPOT ANTHRACNOSE. **Elsinoë piri**, OR, WA.

VIRUS. **Apple Chlorotic Leaf Spot**; **Apple Stem Growing**; **Apple Mosaic**; **Tulare Apple Mosaic**, CA; **Tobacco Mosaic**; **Dapple Apple**, NH; **Green Mottle**, NY; **Stem-pitting**; **Tomato Ringspot**, NY; **Decline** and **Graft Union Necrosis**, WA.

WILT. **Verticillium albo-atrum**.

If this appalling list of diseases should make you think twice before planting apples in the backyard with the expectation of getting cheap and abundant fruit, that is all to the good. There is no easy, or cheap, road to perfect fruit. The commercial grower may, in a wet season, apply nearly 20 sprays to keep scab under control. The homeowner thinks one or two are enough. State experiment stations offer abbreviated schedules for home gardeners, tailored for the area, and if these are followed carefully, a fairly good crop can be expected. There are also all-purpose mixtures available for fruit trees, which may work reasonably well. Scab is the most important apple disease, and proper timing of early season sprays is most essential. Bitter rot, black rot, sometimes rust need attention. Fire blight control is primarily a question of proper pruning to remove infected wood, with an antibiotic spray during bloom.

APPLE-OF-PERU (*Nicandra*)

LEAF SPOT. **Cercospora physaloides**, IN.

ROT, Root. **Phymatotrichum omnivorum**, TX.

VIRUS. **Mosaic**. Unidentified, ID, IA, KY, WA, WI. Experimentally infected with several viruses; **Tomato Leaf Curl**, CA, Mexico.

APRICOT (*Prunus armeniaca*)

BACTERIAL Canker; Gummosis. **Pseudomonas syringae**, CA, OR; **Criconema mutabile**, CA.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, widespread. Japanese apricot (*Prunus mume*) is resistant.

BACTERIAL Fire Blight. **Erwinia amylovora**, CO, FL, NE, PA, TX.

BACTERIAL Leaf Spot. **Xanthomonas pruni**, IL to TX, NE.

BLACK KNOT. **Dibotryon morbosum**, CO, IA, NY.

BLIGHT, Blossom, Twig; Brown Rot. **Monilinia laxa**, Pacific Coast states.

BLIGHT, Shoot; Shot Hole; Fruit Spot. **Coryneum carpophilum**, widespread.

CANKER, Felt Fungus. **Septobasidium pseudopedicellatum**, MS.

CANKER, Trunk. **Phytophthora cactorum**, CA; **P. citrophthora**, CA.

CANKER, Trunk and Limb Gall. **Monochaetia rosenwaldia**, CA.

CANKER, Twig; DIEBACK. **Cytospora** spp., AZ, NY; **Valsa leucostoma**, MO, TX; Cytosporina Dieback, **Eutypa armeniaceae** (syn. **E. lata**), CA; **Ceratocystis fimbriata**, CA.

CANKER; DIEBACK; Coral Spot. **Nectria cinnabarina**, IN, WA.

FRUIT SPOT. **Venturia cerasi** (See under SCAB).

LEAF CURL. **Taphrina deformans**, SC.

LEAF SPOT. **Cercospora circumscissa**, TX; **Coccomyces** sp., CA, MA, TX, VT; **Phyllosticta circumscissa**, CA.

NEMATODE, Dagger. **Xiphinema** sp., WV, NY.

NEMATODE, Lesion. **Pratylenchus vulnus**, CA; **P. penetrans**, NY.

NEMATODE, Root Knot. **Meloidogyne** sp., AZ, TX.

NONPARASITIC. **Arsenical Injury**, from accumulation in soil, CA.

Chlorosis, alkali injury. Mineral deficiency, AZ, CA.

Exanthema. Copper deficiency, CA.

Gummosis, Sour Sap. Adverse soil and moisture conditions, AZ, CA, NJ, WA.

Internal Browning, Fruit Cracking. Boron deficiency, WA.

Little Leaf. Zinc deficiency, CA, OR, WA.

Mottle Leaf. Manganese deficiency, CA.

POWDERY MILDEW. **Podosphaera oxyacanthae**, CA, IA; **Sphaerotheca pannosa**, CA, NY.

ROT, Blossom End; Fruit Spot. **Alternaria** sp., and **A. citri** CA.

ROT, Brown; Blossom Blight. **Monilinia fructicola**, widespread on ripe fruit.
ROT, Green Fruit; Gummosis. **Botrytis cinerea**, CA.
ROT, Green Fruit; Twig Blight. **Sclerotinia sclerotiorum**, CA; **Lambertella pruni**, CA.
ROT, Heart. **Schizophyllum commune**, after freezing, TX, WA; **Trametes hispida**, CO.
ROT, Mushroom Root. **Armillaria mellea**, CA, TX; **Clitocybe tabescens**, FL.
ROT, Root. **Phymatotrichum omnivorum**, AZ, OK, TX.
ROT, Silver Leaf. **Stereum purpureum**, CA.
RUST, **Tranzschelia discolor** and **T. pruni** (II, III), CA, MS, NM, TX.
SCAB; Freckle; Twig Canker. **Cladosporium carpophilum**, wide spread.
VIRUS. **Apricot Gummosis**, WA; **Apricot Pucker Leaf**, UT; **Apricot Ring Pox**, CA, CO, WA; **Peach Mosaic**, Southwest; **Peach Phony**, GA; **Peach Ring Spot**, western U.S.; **Peach Rosette**; **Peach Yellow Bud Mosaic**, CA; **Peach Yellows**, occasional in East; **Stem Pitting**.
WILT. **Verticillium albo-atrum**, CA, UT, WA.

Apricots are very susceptible to Armillaria root rot and should be on resistant Myrobalan rootstock. Bacterial canker is an epidemic disease in many seasons, with activity starting in late autumn, ceasing in early summer. Sprays are usually needed in California for zinc deficiency, brown rot, green or jacket rot, and shot hole.

AQUATIC PLANTS (*Caboriaba* sp., *Limnophila* sp., *Replis diandra*, and *Potamogeton* sp.)

NEMATODE, Foliar. **Aphelenchoides fragariae**, FL.

ARABIS (Rock-Cress)

BLIGHT, Gray Mold. **Botrytis cinerea**, WA.
CLUB ROOT. **Plasmodiophora brassicae**.
DAMPING-OFF. **Rhizoctonia solani**, NJ.
DOWNY MILDEW. **Peronospora parasitica**, AL, AK, CO, IN, MI, TX, WI.
LEAF SPOT. **Septoria arabidis**, CO, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia thlaspeos** (*P. holboelli*) (0, III), on numerous native but not cultivated species in Rocky Mountains and Pacific states; **P. monoica** (0, I) on native species, WI to CO, CA, NM, WA; II, III on *Koehleria* and *Trisetum*.
VIRUS. **Arabis Mosaic**.
WHITE RUST; White Blister. **Albugo candida**, NY to VA, CO, TX, WA.

ARABIDOPSIS

BACTERIAL Leaf Spot. **Xanthomonas campestris** pv. **Campestris**, MI.
ROT, Root. **Sclerotinia minor**, NC.

ARALIA, HERCULES CLUB (*Aralia spinosa*)

CANKER; DIEBACK. **Botryosphaeria ribis**, GA, VA, WV; **Nectria cinnabarina**, VA, WV.
LEAF SPOT. **Cercospora atromaculans**, LA, TX; **Phyllosticta araliae**, TX; **P. everhartii**, TX, WV; **Stagonospora** sp., WV.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX.
ROT, Sapwood. **Polyporus tulipiferae**, MD.
SPOT ANTHRACNOSE; Scab. **Sphaceloma araliae**, MD, MO.

ARALIA, MING (*Polyscias*)

BLIGHT. **Alternaria panax**, FL.

ARALIA, SARSAPARILLA, AMERICAN SPIKENARD (*Aralia hispida, A. nudicaulis, A. racemosa*)

LEAF SPOT. **Alternaria** sp., NY; **Ascochyta marginata**, WI; **Cercospora leptosperma**, IA, MI, NY, WI; **Phyllosticta decidua**, WI; **Ramularia repens**, WI; **Sclerotium deciduum**, WI.
POWDERY MILDEW. **Phyllactinia corylea**, MI, NE.
RUST. **Nyssopsora clavellosa** (III), CA, MN, OR, TX, ME to PA.
WILT. **Verticillium albo-atrum**, NY.

ARALIA, UDO (*Aralia cordata*)

BLIGHT. **Alternaria** sp., DE, NJ.
ROT, Stem. **Sclerotinia sclerotiorum**, MD.
WILT. **Verticillium albo-atrum**, MD, PA.

ARAUCARIA (Monkey-Puzzle, Norfolk-Island-Pine)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA.
BLIGHT. **Cryptospora longispora**.
LEAF SPOT. **Pestalotia funerea**, CA, and **P. micheneri**, PA, probably secondary; **Stictis araucariae**, CA.
ROT, Root. **Cylindrocladium clavatum**, FL.

ARBORVITAE (*Thuja*)

BLIGHT, Fire. **Cercospora thujina**, on oriental arborvitae, AR, GA, LA, MS, TX.
BLIGHT, Gray Mold. **Botrytis cinerea**, NJ.
BLIGHT, Leaf. **Didymascella thujina**, TX, VT to WI.
BLIGHT, Nursery. **Phomopsis juniperovora**, IN, KY, OH, PA, VA; **P. occulta**, secondary.
BLIGHT, Snow. **Phacidium infestans**, Northeast.
BLIGHT, Twig. **Alternaria** sp.; **Mycosphaerella** sp; **Pestalotia funerea**; **Phytophthora** sp.; **Heterosporium** sp., OR.
BLIGHT, Twig. **Coryneum berckmansii** on oriental arborvitae, OR, WA.
CANKER, Bark Patch. **Aleurodiscus amorphus**; **A. nivosus**, other species.
CANKER, Cypress. **Coryneum cardinale**, CA.
CANKER; DIEBACK. **Diplodia** sp., AL, FL.
DAMPING-0FF. **Rhizoctonia solani**, NM, NY, TX, VA.
NEEDLE CAST. **Lophodermium thujae**, ME, NH, NY, WI.
ROT, Mushroom Root. **Armillaria mellea**, MI, MS, NY, TX; **Clitocybe tabescens**, FL, LA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Fusarium solani**, TX.
ROT, Wood. **Fomes annosus**, MI; **F. roseus**, ME; **Poria vaporaria**, **P. weirii**, Great Lakes states; **Lenzites saepiaria**, MN; **Polyporus** spp.; **Schizophyllum commune**, ME; **Trametes** spp.

Giant arborvitae used for timber has many more wood rots than those listed. Oriental arborvitae in the South often looks as if blighted by fire, with nursery losses higher than in gardens. A copper spray, monthly from June to September, controls this blight. In the Northwest **Coryneum berckmansii** causes discoloration and shedding of branches, while **C. cardinale** is sporadically injurious.

ARCTOTIS

LEAF BLOTCH. **Cercospora** sp., FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.

ARDISIA

LEAF SPOT, Algal. **Cephaleuros virescens**, FL.

ARGYREIA

NEMATODE, Root Knot. **Meloidogyne** sp., SC.
ROT, Root. **Phymatotrichum omnivorum**, TX.

ARMERIA (Sea-Pink, Thrift)

RUST. **Uromyces armeriae** (0, I, II, III), CA, OR.

ARNICA

LEAF SPOT. **Ovularia hughesiana**, MT; **Phyllosticta arnicae**, CO, MT, UT, WY.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CO; **Sphaerotheca macularis** (*S. humuli* var. *fuliginea*), AK, CA, WA, WY.
RUST. **Puccinia arnicalis** (II III) AK, to MT, CA, CO; 0, I unknown; **Uromyces junci** (0, I), CA, CO, MT, OR, SD, WY; II, III on *Juncus* spp.
SMUT, White. **Entyloma arnicale**, AK, CO, ID, MT, UT, WA, WY.

ARROW-ARUM (*Peltandra*)

LEAF SPOT. **Cercospora callae**, AL, DE, FL, NY; **Colletotrichum** sp., AL; **Gloeosporium paludosum**, DE, IN, MA, NY; **Pestalotia aquatica**, secondary; **Ramularia** sp., MI.

RUST. **Uromyces ari-triphylli** (*U. caladii*) (0, I, II, III), MA to FL, IL, IN, IA.

ARROWHEAD (*Sagittaria*)

LEAF SPOT. **Cercospora alismatis** VT to AL, TX, WI; **Didymaria alismatis**, **Gloeosporium confluens**, IA, MA, TX, WI; **Marssonina** sp., LA.

SMUT, Leaf. **Burrillia pustulata**, IL, NE, WI; **Doassansia deformans**, MA to NJ, FL, MO, SD, TX; **D. furva**, WI; **D. intermedia**, IA, MN, NH, ND, WI; **D. obscura**, CT, MA; **D. opaca**, MA to DE, IL, WI; **D. sagittariae**, CT to KS, AR, MT, TX, WY.

ARROWROOT (*Maranta*)

LEAF SPOT. **Glomerella cingulata**, MD, NJ.

RUST. **Puccinia thaliae** (*P. cannae*) (II, III), FL.

ARTEMISIA (Wormwood)

BLIGHT, Leaf. **Cercospora olivacea**, NJ, NY, ND; **Systremma artemisiae**, black pustule, PA.

DOWNY MILDEW. **Peronospora leptosperma**, IA, MN, ND, SD, WI.

GALL, Leaf. **Synchytrium aureum**, WI.

LEAF SPOT. **Cercospora ferruginae**, NY, WI; **Gloeosporium heterophyllum**, CA.

LEAF-HAIRS, DISCOLORATION. **Nematostoma artemisiae**, MO.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, IA, SD, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia tanaceti** (*P. absinthii*) (0, I, II, III), CA; **P. atrofusca** (0, I) ND; II, III on *Carex* spp.; **P. millefolii** (III), CA.

VIRUS. **Tomato Spotted Wilt**, PA.
WHITE RUST. **Albugo tragopogonis**, IA, MT, ND, SD, TX, WI.

ARTICHOKE, GLOBE (*Cynara scolymus*)

BLIGHT, Gray Mold. **Botrytis cinerea**, CA, NY.
BLIGHT, Southern. **Sclerotium rolfsii**, GA.
LEAF SPOT. **Cercospora obscura**, CA, TX; **Cladosporium** sp., CA, SC; **Ramularia cynarae**, CA, prevalent.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, NJ.
ROT, Root. **Phytophthora megasperma**, CA; **Phymatotrichum omnivorum**, TX.; **Pythium aphanidermatum**, CA.
ROT, Root and Stem. **Rhizoctonia solani**, MS, TX; **Sclerotinia sclerotiorum**, OR.
VIRUS. **Artichoke Curly Dwarf**; **Artichoke Latent**, CA.
WILT. **Verticillium dahliae**, CA.

ARTICHOKE, JERUSALEM (*Helianthus tuberosus*)

BACTERIAL Leaf Spot. **Pseudomonas syringae pv. tagetis**, MN.
BACTERIAL Spot. **Pseudomonas helianthi**, IL.
BLIGHT, Southern. **Sclerotium rolfsii**, CA, FL, LA, MS, SC, TX.
DOWNY MILDEW. **Plasmopara halstedii**, VT and NJ to KS, SD.
LEAF SPOT. **Cercospora helianthi**, KS; **Septoria helianthi**, IL, IA, WI.
NEMATODE, Root Knot. **Meloidogyne** spp., CA, FL, MD, NY, SC, TN.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Root. **Phymatotrichum omnivorum**, AZ, TX; **Rhizopus stolonifer**, MS.
ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, MA, MN, WA.
RUST. **Coleosporium helianthi** (II, III), AL, IL, NY, NC, OK, PA, SC, TN, VA; **Puccinia helianthi** (0, I, II, III), general; **Uromyces junci**, (0, I), NE, ND.

ARTILLERY PLANT, ALUMINUM PLANT (*Pilea*)

BACTERIAL Leaf Spot. **Xanthomonas campestris**, FL.
BLIGHT, Leaf, Stem, and Bud. **Phytophthora parasitica**, FL.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.
LEAF SPOT. **Myrothecium roridum**, FL; **Septoria pileae**, IL, IN, IA, MI, MO, NY, WI.
ROT. **Rhizoctonia** sp., FL.

ARTOCARPUS (Breadfruit)

RUST. **Uredo artocarpi** (11), HI.

ARUGULA (*Eruca sativa*)

BACTERIAL Blight. **Pseudomonas syringae** pv. **alisalensis**, CA.
BACTERIAL Leaf Spot. **Pseudomonas syringae**, CA.
DOWNY MILDEW. **Peronospora parasitica**, CA.
WHITE RUST. **Albugo candida**, CA.

ARUNDO (Giant Reed)

LEAF SPOT; Stem Speckle. **Selenophoma donacis**, CA.
LEAF SPOT; Cane "Anthracnose"; Dieback. **Papularia sphaerosperma**, general. **P. odorae**, KS; **Phyllosticta tuberosa**, OK.
ROT, Root. **Armillaria mellae**, MD.
RUST. **Puccinia chloridis** (*P. bartholomaei*) (0, I), KS, OK, TX; II, III on *Bouteloua* spp.; **Uromyces asclepiadis** (II, III), KS, NM, TX.
RUST, Crown. **Puccinia coronata**, CA.

ASH (*Fraxinus*)

ANTHRACNOSE, Leaf Scorch. **Discula fraxinea**, DE, LA, OR; **Gloeosporium aridum**, eastern and central states.
BACTERIAL Phytoplasma. **Ash Yellows, Witches' Broom**, MI, MT, NE, NC, SD.
BACTERIAL Decline. **MLO**, IL, IN, IA, NY.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, IA, NE to OK.
BLACK MILDEW. **Dimerosporium pulchrum** (*Sarcinella heterospora*).
BLIGHT, Seedling. **Rhizoctonia solani**, OK.

CANKER, Bark Patch. **Aleurodiscus** spp., eastern states; **Felt Fungus**, **Septobasidium** spp., NC to FL.

CANKER, Branch, Trunk. **Dothiorella fraxinicola**, IA, KS, NE; **Sphaeropsis** sp., widespread; **Nectria cinnabarina**; **N. coccinea**, Northeast.

CANKER, Coin. **Phyctema vagabunda**, MT, Ontario, Canada.

CANKER; DIEBACK. **Cytospora annularis**, north central states; **Diplodia infuscans**, Northeast; **Cytophoma pruinosa** and **Fusicoccum** sp., may be secondary, Northeast.

DECLINE. **Togninia fraxinopennsylvanica**, Anamorph, **Phaeoacremonium mortoniae**, CA.

DODDER. **Cuscuta** sp.

LEAF SPOT. **Cercospora fraxinites**, AL, FL, LA, TX; **Cylindrosporium fraxini** (including reports of *Marssonina fraxini, Piggotia fraxini*), widespread; **Mycosphaerella effigurata**, widespread; **M. fraxinicola**; **Actinopelte dryina**; **Cytospora** sp., VA.

MEASLES. **Togninia fraxinopennsylvanica** Anamorph, **Phaeoacremonium mortoniae**, CA.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), south central to Pacific states.

MISTLETOE. **Viscum album**, CA, on *Fraxinus velutina* (Arizona Ash).

MISTLETOE. European. **Viscum album** on Arizona ash, CA.

NEMATODE. **Meloidogyne** spp., AZ, MD, OK.

NEMATODE, Dagger. **Xiphinema americanum**, SD on Green Ash.

POWDERY MILDEW. **Phyllactinia corylea**, northeastern, central, Pacific Coast states. **Uncinula circinata**, IA; **Microsphaera alni**, IL.

ROT, Collar. **Helicobasidium purpureum**, TX.

ROT, Root. **Phymatotrichum omnivorum**, AZ, TX.

ROT, Sapwood. **Lentinus tigrinus**, MS.

ROT, White Mottled Heart, Stem. **Fomes fraxinophilus**, eastern and central states to Great Plains; many other species of *Fomes*.

ROT, Wood. **Daldinia concentrica**, cosmopolitan; **Daedalea** spp.; **Ganoderma lucidum**, LA, MS; **Polyporus** spp.; **Poria** spp.; **Schizophyllum commune**, cosmopolitan; **Trametes** spp.

RUST. **Puccinia sparganioides** (0, I), general east of Great Plains; II, III on marsh grass (*Spartina* spp.).

VIRUS. **Ash Ring Spot**, NY; **Tobacco Mosaic Virus**, MA, NY; **Tobacco Ring Spot Virus**, NY.

WILT. **Verticillium albo-atrum**, CO; **V. dahliae**, OR.

Ash rust is epidemic in New England in many seasons, causing defoliation and sometimes death of trees. Anthracnose and leaf spots may be important in a wet season.

ASH, MORAINE (*Fraxinus holotriocha*)

VIRUS. **Tobacco Mosaic**, NY; **Tobacco Ringspot**, NY.

ASPARAGUS (*Asparagus officinalis*)

ANTHRACNOSE; Canker. **Colletotrichum** sp., AL, CT, IL.
BACTERIAL Soft Rot. **Erwinia carotovora**, general.
BLIGHT, Branchlet; DIEBACK. **Alternaria** sp., IL, MA, NY, OK, SC; **Stemphylium botryosum**, secondary; **Ascochyta** sp., DE, TX.
BLIGHT, Ashy Stem. **Macrophomina phaseoli**, TX.
BLIGHT, Gray Mold, Shoot. **Botrytis cinerea**, CA, IL, MA, NY, WV.
CANKER; Stem Spot. **Phoma asparagi**.
DAMPING-OFF; Stem Canker. **Rhizoctonia solani**, occasional.
LEAF SPOT. **Cercospora asparagi**, general; **Pleospora herbarum**; **P. allii** Anamorph, **Stemphylium vesicarium**, MI, OK, WA.
NEMATODE, Root Knot. **Meloidogyne** sp., SC. Usually resistant.
ROT, Crown. **Penicillium martensii**, WA; **Penicillium** sp., blue mold rot.
ROT, Mushroom Root. **Armillaria mellea**, OR.
ROT, Root; Stem Wilt; Decline. **Fusarium oxysporum** f. sp. **asparagi**, CA, SC, WA; **Fusarium proliferatum**, CT; **Fusarium** sp.; **Phytophthora** sp., MI; **P. megasperma**, Montreal, Canada.
ROT, Stem. **Diplodia asparagi**; **Phytophthora** sp., CA.
ROT, Watery Soft. **Sclerotinia sclerotiorum**, occasional in South.
RUST. **Puccinia asparagi** (0, I, II, III), general on susceptible varieties. Rust is the most important asparagus disease, and resistant varieties are sometimes disappointing.
VIRUS. Asparagus I, DE, MI, NJ; Asparagus II, DE; Tobacco Streak.

ASPARAGUS FERN (*Asparagus plumosus*)

CANKER, Stem; Blight. **Ascochyta asparagina**, FL, TX; **Phoma** sp., FL.
LEAF MOLD. **Cladosporium** sp., FL, MS, TX.

NEMATODE, Root Knot. **Meloidogyne** spp., FL.
NEMATODE, Spiral. **Helicotylenchus nannus**.
NONPARASITIC "Rust". Cause undetermined, FL.
ROT, Root; Wilt. **Fusarium** sp., FL, WA.

ASPARAGUS, FLORISTS' SMILAX (*Asparagus asparagoides*)

LEAF SPOT. **Stagonospora smilacis**, WI.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
ROT, Root; Wilt. **Fusarium** sp., NJ.

ASPARAGUS, SPRENGER (*Asparagus sprengeri*)

BACTERIAL Crown Gall; Fasciation. **Agrobacterium tumefaciens** (possibly confused with *Clavibacter fascians*).
NEMATODE, Root Knot. **Meloidogyne** spp., CA.
ROT, Root. **Rhizoctonia solani**, NY.

ASPARAGUS TREE FERN (*Asparagus virgatus*)

BACTERIAL, Water Soaked Lesions. **Xanthomonas translucens** pv. **undulosa**, MI.
BACTERIAL Lesion. **Xanthomonas campestris**, FL.

ASPIDISTRA

BLIGHT, Leaf. **Labrella aspidistrae**, IL, LA.
LEAF SPOT. **Ascochyta aspidistrae**, MN, NJ; **Colletotrichum omnivorum**, CA, MO, NJ, PA, WV.

ASTER, CHINA (*Callistephus*)

ANTHRACNOSE. **Colletotrichum** sp., FL.
BACTERIAL, MLO. **Aster Yellows**, general.
BLIGHT, Bud, Stem; Gray Mold. **Botrytis cinerea**, AK, CA, CT, IL, NJ, NY, PA, WI.
BLIGHT, Petal. **Itersonilia perplexans**, FL.

BLIGHT, Southern. **Sclerotium rolfsii**, MS, NC.
CANKER, Stem. **Phomopsis callistephi**, IL, WI.
DODDER, **Cuscuta** spp., widespread.
DOWNY MILDEW. **Basidiophora entospora**, FL, TX.
LEAF SPOT. **Ascochyta asteris**, CA, NY, ND, OH; **Septoria callistephi**, AL, DE, MI, MO, NJ, NY, OH, PA.
MOLD, Seed. **Pleospora herbarum**, cosmopolitan; **Alternaria** sp.
NEMATODE, Root Knot. **Meloidogyne** sp., CT, FL, TX, WA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, DE, MN, NE, NC, VT, WA; **Erysiphe polygoni**, NJ.
ROT, Foot. **Phytophthora cryptogea**; **Pythium ultimum**.
ROT, Root and Stem; Leaf Blight. **Rhizoctonia solani**, widespread, chiefly in northeastern and central states; **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium asterum** (*C. solidaginis*) (II, III), general except far South; II, III on two- and three-needle pines.
VIRUS. **Beet Curly Top**, OR.
VIRUS. **Tobacco Rattle** (aster strain of); **Tomato Spotted Wilt**, CA; **Bidens Mottle**, FL.
WILT. **Verticillium** sp., CA, CT, IL, MA, NY.
WILT, Stem Rot. **Fusarium oxysporum** f. sp. **callistephi**, general.

Fusarium wilt and aster yellows are the two principal diseases. Choose wilt-resistant varieties or plant in a new location. Rogue plants with yellows immediately; use systemic insecticides to control insect vectors.

ASTER, PERENNIAL (*Aster* spp.)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT.
BLACK KNOT. **Gibberidea heliopsidis**, NE, NY, ND, WI.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, CT, NJ.
DODDER. **Cuscuta** spp., eastern and central states.
DOWNY MILDEW. **Basidiophora entospora**, IL, IN, MD, MO, NE, WI.
GALL, LEAF. **Synchytrium nigrescens**, WI.
LEAF SPOT. **Alternaria** sp., MI, TX, VT; **Ascochyta compositarum**, WI; **Cercospora asterata**, AL, TX; **Cercosporella cana**, OR, WI; **Leptothyrium doelligeriae**, NY; **Ovularia asteris**, WY; **O. virgaureae**, CO, MS, WI; **Phyllachora sterigena**, KS, NE; **Ramularia asteris**, IA, MI, NE, TX, WI, WY; **Septoria angularis** and other species; **Phyllosticta astericola**, TX.

LEAF SPOT, Black, Tar. **Placosphaeria haydeni** (*Discosphaerina pseudimantia*), IA, NJ, NY, ND.
NEMATODE, Leaf. **Aphelenchoides ritzemabosi**, CT.
NEMATODE, Root Knot. **Meloidogyne** sp.
PARASITIC LICHEN. **Strigula elegans**, **S. complanata**, LA, Southern U.S.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, CT.
RUST. **Coleosporium asterum** (II, III); **Puccinia asteris** (III), general; **P. dioicae** var. **asteris** (0, I); II, III on sedge; **P. grindeliae** (III), CO, KS, NV, WY; **P. stipae** (0, I), CO, IA, KS, NE, ND, SD; **Uromyces compactus**, AZ, NM, TX; **U. junci** (0, I), NH.
SMUT, White. **Entyloma aster-seriaceanum**, WI; **E. compositarum**, ME, MA, SD, WI.
VIRUS. **Aster Chlorotic Stunt; Mosaic**. Unidentified, CA.
VIRUS. **Tomato Spotted Wilt**, CA.
WILT. **Verticillium albo-atrum**, CT.

ASTILBE

POWDERY MILDEW. **Erysiphe polygoni**, MA.
ROT, Petiole. **Sclerotium rolfsii** var. **delphinii**, IA.
WILT. **Fusarium** sp., WA.
VIRUS. **Tobacco Ringspot**, MN.

ASTRAGALUS

RUST. **Uromyces punctatus**, ID, OR.

AUBRIETTA

VIRUS. **Tomato Spotted Wilt**, PA.

AUCUBA (Gold-Dust Tree)

ANTHRACNOSE; Leaf Spot. **Gloeosporium** sp. (*Glomerella cingulata*), NJ, PA, SC, WA. Probably includes reports of *Colletotrichum pollaci*, MS, NJ.

LEAF SPOT. **Pestalotia aucubae**, secondary; **Phyllosticta aucubae**, CA, MS, SC.
ROT, Root. **Phytophthora cinnamomi**, **P. citricola**, NC.
VIRUS. **Tobacco Mosaic**, Aucuba strain.
WILT. **Verticillium albo-atrum**, NJ.

AUTUMN CROCUS (*Colchicum*)

BLIGHT; Leaf Spot. **Botrytis elliptica**, WA.
SMUT, Leaf. **Urocystis colchici**, DE, NY, OH, PA, WA.
VIRUS. **Tobacco Ring Spot Virus**, MD.

AVOCADO (*Persea americana*)

ANTHRACNOSE; Leaf and Fruit Spot; Black Rot. **Glomerella cingulata**, general.
BACTERIAL CANKER. **Xanthomonas campestris**, CA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA.
BACTERIAL Fruit Blast. **Pseudomonas syringae**, CA.
BLACK MILDEW. **Irene perseae**, FL.
BLACK STREAK. No causal agent has been identified, FL.
BLIGHT, Seedling. **Sclerotium rolfsii**, FL; **Phytophthora palmivora**, FL.
BLOTCH, Fruit Spot. **Cercospora perseae**, FL; **C. purpurea**.
CANKER, Branch; Dothiorella Fruit Rot. **Botryosphaeria ribis** var. **chromogena**, CA.
LEAF SPOT. **Phyllosticta micropuncta**, AL, FL.
LEAF SPOT; Algal; Green Scurf. **Cephaleuros virescens**, FL.
LEAF SPOT; Fruit Spot; Seedling Blight. **Pestalotia** spp., general.
LEAF SPOT; Smudgy Spot on Twigs. **Helminthosporium** sp., CA.
NEMATODE, Burrowing. **Radopholus similis**, FL.
NEMATODE, Dagger. **Xiphinema americanum**.
NEMATODE, Meadow. **Pratylenchus brachyurus**; **P. vulnus**.
NEMATODE, Root Knot. **Meloidogyne** sp., resistant to.
NEMATODE, Stubby Root. **Trichodorus christiei**.
NONPARASITIC. **Carapace Spot**. Abrasion of young fruits.
Dieback. Copper deficiency.
End Spot. Dessication of young fruits; overmaturity.

Little Leaf; Rosette. Zinc deficiency.
Melanorhiza. Defective drainage and aeration.
Mottle Leaf. Nutritional deficiency.
Tipburn. Sometimes salt accumulation in poorly drained soil.
ROT, Blue Mold. **Penicillium expansum**, CA.
ROT, Collar; Trunk Canker. **Phytophthora cactorum** CA; **P. parasitica** FL; **Sclerotinia sclerotiorum**, CA.
ROT, Fruit. **Diplodia theobromae**, FL; **Phomopsis** sp., FL, TX; **Phytophthora citrophthora**, CA; **P. citricola**, CA; **Rhizopus nigricans**; **Alternaria** sp.; **Fusarium** sp.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX; Dematophora Rot, **Rosellinia necatrix**.
ROT, Root; Decline. **Phytophthora cinnamomi**, CA; **Pythium** spp., CA.
ROT, Seed and Root. **Rhizoctonia solani**, CA.
SPOT ANTHRACNOSE; Scab. **Sphaceloma perseae**, FL, TX.
VIRUS. **Avocado Sun Blotch**, CA; **Avocado 3 Alphacryptovirus**., CA, black streak.
WILT. **Verticillium albo-atrum**, CA, FL.
Avocado scab may cause heavy damage in susceptible varieties of West Indian stock. Cercospora blotch attacks both leaves and fruit. Decline, root rot, is most serious in wet soils, killing trees if they are waterlogged 6 to 8 days.

AZALEA (*Rhododendron*)

ANTHRACNOSE. **Colletotrichum** sp., LA.
BLIGHT, Bud and Twig. **Briosia azaleae** (*Pycnostysanus*), MA, NH, NJ, NC.
BLIGHT, Cutting. **Cylindrocladium scoparium**, AL, FL, NY, OH; **C. floridanum**. BLIGHT, Flower; Seedling. **Botrytis cinerea**, often after frost, cosmopolitan; **Alternaria tenuis**; **Cladosporium herbarum**; **Epicoccum purpurascens**.
BLIGHT, Foliar. **Phytophthora foliarum**, TN.
BLIGHT, Petal; Flower Spot. **Ovulinia azaleae**, AL, CA, FL, GA, LA, MD, MS, NC, PA, SC, TX, VA; also NY, NJ in greenhouses.
BLIGHT, Shoot. **Monilinia azaleae**, GA, MA, NY.
BLIGHT, Shoot and Stem. **Phytophthora citrophthora**, **P. citricola**, **P. nicotianae** var. **parasitica**, FL, OH.

BLIGHT, Thread. **Pellicularia koleroga**, LA.
CANKER, Stem. **Gloeosporium** sp., OR. **Phomopsis** sp., SC.
DAMPING-OFF, Leaf Blight. **Rhizoctonia solani**, cosmopolitan.
DODDER. **Cuscuta** sp., FL, SC.
GALL, Leaf; Shoot Hypertrophy. **Exobasidium vaccinii**, general; **E. burtii**, **Yellow Leaf Spot**, ID, NJ, OR, WA; **Synchytrium vaccinii**, NJ.
LEAF SCORCH; Angular Leaf Spot. **Septoria azaleae**, widespread; severe in CA.
LEAF SPOT. **Cercospora rhododendri**, MD; **Pestalotia** spp., general but secondary; **Phyllosticta** sp.; **Ramularia angustata**, MS, NY; **Colletotrichum azaleae**, FL; **Septoria solitaria**, CA, OR, TX; Tar Spot, **Melasmia menziesii**, WA; **Corynespora cassiicola**, GA, FL.
NONPARASITIC. **Chlorosis**. Usually iron deficiency, general in alkaline soils, sometimes defective drainage.
NEMATODE, Leaf. **Aphelenchoides fragariae**, FL.
NEMATODE, Root Knot. **Meloidogyne incognita**.
NEMATODE, Spiral. **Helicotylenchus nannus**; **Rotylenchus robustus**.
NEMATODE, Stubby Root. **Paratrichodorus christiei**; **Trichodorus primitivus**.
NEMATODE, Stunt. **Tylenchorhynchus claytoni**.
POWDERY MILDEW. **Erysiphe azaleae**, LA; **Erysiphe polygoni**, CA, NJ; **Microsphaera alni**, GA, NJ, NY, PA, RI, VA.
ROT, Root. **Armillaria mellea**, CA, NJ, WA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX; **Pythium** spp.; **Phytophthora lateralis**, NC.
ROT, Root and Stem; Wilt. **Phytophthora cinnamomi**, AL, MD, MO.
RUST. **Pucciniastrum myrtilli** (II, III), ME to FL, TX; 0, I on hemlock.
VIRUS. **Tomato Spotted Wilt**, PA.
WILT. **Cylindrocarpon radicicola**, MA.

Azalea flower spot or petal blight devastates azalea blooms in the South in rainy or foggy weather starting when buds show color. Bud and twig blight has killed some shrubs in Massachusetts. Leaf galls are unsightly but not too serious. Leaf scorch may be prevalent in a rainy season. Powdery mildew is common on deciduous azaleas in late summer.

AZARA

ROT, Stem. **Sclerotium rolfsii**, CA.

BABIANA

VIRUS. **Iris Mosaic**, CA.

BALD CYPRESS (*Taxodium*)

BLIGHT, Twig. **Pestalotia funerea**, TX.
CANKER, Felt Fungus. **Septobasidium** spp., LA.
ROT, Brown Pocket Heart. **Fomes geotropus**, cause of "pecky cypress," FL to LA; **F. extensus**; **Ganoderma applanatum**.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Lenzites** spp., **Polyporus** spp., **Poria** spp.

BALM (*Melissa*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Phyllosticta decidua**, NY.

BALSAM-APPLE, BALSAM-PEAR (*Momordica*)

ANTHRACNOSE. **Colletotrichum lagenarium**, IN.
DOWNY MILDEW. **Pseudoperonospora cubensis**, IA.
LEAF SPOT; Blight. **Ramularia momordicae**, TX.
NEMATODE, Burrowing. **Radopholus similis**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
POWDERY MILDEW. **Golovinomyces cichoracearum**, WI.

BALSAM-ROOT (*Balsamorhiza*)

LEAF SPOT. **Septoria** sp., WA.
NEMATODE, Leaf Gall. **Anguina balsamophila**, UT.
POWDERY MILDEW. **Golovinomyces cichoracearum**, WY.
RUST. **Puccinia balsamorhizae** (0, I, II, III), general.

BAMBOO (*Bambusa, Phyllostachys*)

BLACK MILDEW. **Meliola tenuis**.
BLIGHT, Tip. **Diplodia bambusae**, LA, TX.

LEAF MOLD. **Cladosporium gramineum**, OR, SC.
LEAF SPOT. **Helminthosporium** sp., FL; **Mycosphaerella** sp., CA; Culm Spot, **Selenophoma donacis**, CA.
NEMATODE, Burrowing. **Radopholus similis**, FL.
RUST. **Puccinia melanocephala** (II, III), FL, GA, MS, TX; **Uredo ignava** (II), FL, GA.
RUST. **Uromyces costaricensis**, FL. on Wild Bamboo (*Lasiacis divaricata*).
SMUT. **Ustilago shiraiana**, CA, FL, LA, TX.
VIRUS. **Bamboo Mosaic**, CA; **Sugarcane Mosaic Virus**, LA, on *Arundinaria gigantea*.

BANANA, DWARF (*Musa nana*)

ANTHRACNOSE; Fruit Rot. **Gloeosporium musarum**, FL, TX.
BACTERIAL Leaf Blight. **Pseudomonas solanacearum**, FL.
BLACK SIGATOKA. **Mycosphaerella fijiensis**, FL; Grand Bahama Island, Puerto Rico.
NEMATODE, Burrowing. **Radopholus similis**, FL, LA.
NEMATODE, Lesion. **Pratylenchus musicola**, FL.
NEMATODE, Root Knot. **Meloidogyne** spp., FL, TX.
ROT, Root. **Clitocybe tabescens**, FL.
VIRUS. **Cucumber Mosaic**, FL.
WILT. **Fusarium oxysporum** f. sp. **cubense**, FL.

BANANA SHRUB (*Michelia figo*)

POWDERY MILDEW. **Oidium** sp., LA.

BANEBERRY, COHOSH (*Actaea*)

LEAF SPOT. **Ascochyta actaeae**, WI; **Ramularia actaeae**, CO, IA, NM, VT, WI.
RUST. **Puccinia recondita** (0, I), NY to VA, IL, WA; II, III on grasses.
SMUT, Leaf and Stem. **Urocystis carcinodes**, ID, PA, UT, WV.

BAPTISIA (False Indigo)

LEAF SPOT. **Cercospora velutina**, IL, KS, WI; **Marssonina baptisiae**, IA; **Septoria baptisiae**, SC, TX; **Stagonospora baptisiae**, SC.
POWDERY MILDEW. **Erysiphe polygoni**, prevalent; **Microsphaera alni**, WI.
ROT, Root. **Armillaria mellea**, CA; **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia andropogonis**, KS, NE, NC, OK.

BARBERRY (*Berberis*)

BACTERIAL Leaf Spot. **Pseudomonas berberidis**, general.
BLIGHT, Gray Mold. **Botrytis cinerea**, CA, MO.
CANKER; DIEBACK. **Botryosphaeria ribis**, FL.
DAMPING-OFF. **Pythium debaryanum**, CA.
LEAF SPOT. **Gloeosporium berberidis**, CT, MA, MN, OH, WI; **Phyllosticta berberidis**, KY.
NEMATODE, Root Knot. **Meloidogyne hapla**.
NEMATODE, Spiral. **Rotylenchus buxophilus**.
POWDERY MILDEW. **Erysiphe polygoni**; **Phyllactinia corylea**, MA, VT.
ROT, Heart. **Poria punctata**, MD.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Cumminsiella sanguinea** (0, I, II, III), OR; **Puccinia koeleriae** (0, I); II, III on Koehleria; **P. montanensis** (0, I); II, III on grasses.
RUST, Wheat, **Puccinia graminis** (0, I), general; II, III on cereals and grasses.
VIRUS. **Tomato Spotted Wilt**, PA.
WILT. **Verticillium albo-atrum**, CT to VA, IL, MI.
All interstate movement of barberry is under quarantine because of the wheat rust, but resistant cultivars may be shipped under permit. Common barberry is eradicated near wheat fields; Japanese barberry is resistant to rust.

BARLEY

ERGOT. **Claviceps purpurea**, ND.

BARREN-STRAWBERRY (*Waldsteinia*)

LEAF SPOT. **Ramularia waldsteiniae**, WI; **Septoria waldsteiniae**, MI, NY, VT.
RUST. **Puccinia waldsteiniae**, ID, MI, NY, VT, WI.
SMUT. **Urocystis** (*Whetzella*) **waldsteiniae**, NY, WI.

BARRENWORT (*Epimedium*)

VIRUS. **Tobacco Rattle**, MA, MI, MN.

BASIL (*Ocimum*)

BACTERIAL Leaf Spot. **Pseudomonas cichorii**, LA; **P. viridiflava**, CA.
NONPATHOGENIC. Hydroponically grown chlorosis (interveinal), CO_2-enrichment, IL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL; **M. incognita acrita**, CA.
ROT, Basal. **Rhizoctonia solani**, HI.
ROT, Root. **Phytophthora dreschleri**, NC; **Pythium irregulare**, FL.
ROT, Stem. **Sclerotinia sclerotiorum**, LA, also dieback, CA; **S. minor**, CA, also crown.
SPOT, Black. **Colletotrichum gloeosporioides**, FL.
VIRUS. **Bromegrass Mosaic Virus**, general, IA, SD; **Tomato Spotted Wilt**, LA, PA.
WILT. **Fusarium oxysporum** f. sp. **basilicum**, CA, FL, HI, LA, MD, MA, SC; **Sclerotinia sclerotiorum**.

BAUHINIA (Orchid-Tree, Mountain Ebony)

LEAF SPOT. **Colletotrichum** sp., TX; **Phyllosticta** sp., FL.
POWDERY MILDEW. **Microsphaera diffusa**, MD.

BAYBERRY (*Myrica carolinensis*)

LEAF SPOT. **Mycosphaerella myricae**, GA, MS; **Phyllosticta myricae**, NY.

RUST. **Gymnosporangium ellisii** (0, I), MA to NY, VA; III on *Chamaecyparis*.
VIRUS. **Bayberry Yellows**, NJ.

BEAN, ADZUKI (*Phaseolus angularis*)

BACTERIAL Stem Rot. **Pseudomonas adzukicola**, MN.

BEAN, FABA (*Vicia*)

VIRUS. **Bidens Mottle**, FL.

BEAN, KIDNEY, LIMA (*Phaseolus vulgaris, P. limensis*)

ANTHRACNOSE. **Colletotrichum lindemuthianum**, general in East, race 73, ND; **C. truncatum**, PA to AL, IA, TX.
BACTERIAL Blight. **Xanthomonas phaseoli**, general in East, rare Pacific Coast.
BACTERIAL Halo Blight; Grease Spot. **Pseudomonas syringae** pv. **phaseolicola**, general in East, rare on Pacific Coast.
BACTERIAL Northern Wilt. **Clavibacter flaccumfaciens**, Northeast.
BACTERIAL Pink Seed. **Erwinia rhapontici**, Alberta, Canada.
BACTERIAL Stem Rot. **Pseudomonas adzukicola**, MN.
BACTERIAL Soft Rot. **Erwinia carotovora**, cosmopolitan in market.
BACTERIAL Southern Wilt; Brown Rot. **Pseudomonas solanacearum**, AL, FL, GA, OK.
BACTERIAL Spot, Leaf and Pod. **Pseudomonas syringae**, widespread.
BACTERIAL "Stickiness". **Pseudomonas coadunata**, CA; **P. ovata**, VA.
BACTERIAL "Wildfire". **Pseudomonas syringae** pv. **tabaci**, MA, NC.
BACTERIAL Wilt. **Curtobacterium flaccumfaciens** subsp. **flaccumfaciens**, ND; Alberta, Canada, NE.
BLIGHT, Ashy Stem; Charcoal Rot. **Macrophomina phaseoli**, MD to GA, CA, CO.
BLIGHT, Gray Mold. **Botrytis cinerea**, occasional.
BLIGHT, Phytophthora. **Phytophthora capsici**. IL; **Choanephora cucurbitarum**, FL.

BLIGHT, Pod. **Diaporthe phaseolorum**, CT to FL, LA, OH, OK, on lima bean.

BLIGHT, Southern. **Sclerotium rolfsii**, VA to FL, AR, CA, TX.

DAMPING-OFF. **Pythium ultimum**; **P. debaryanum**; **Rhizoctonia solani**.

DOWNY MILDEW. **Phytophthora phaseoli**, on lima bean, East, central states; **P. capsici**, DE, MD, NJ.

LEAF AND POD SPOT. **Ascochyta boltshauseri**, NC, OR, PA; **A. phaseolorum**, WA; **Bipolaris sorokinearia**, WI.

LEAF AND STEM DISEASE. **Cercospora zebrina** (clover isolate), NC.

LEAF SPOT. **Alternaria** spp.; **Aristastoma oeconomicum**,GA, VA; **Cercospora canescens**, southeastern states to NY; **Epicoccum** sp., secondary on lima bean; **Isariopsis griseola**, Angular Leaf Spot, ME to FL, OK, TX; **I. laxa**, IN, NJ; **Mycosphaerella cruenta**, NJ to FL, AR, TX, WI; **Phyllosticta phaseolina**, NY to FL, IN, TX; **Stemphylium botryosum**; **Stagonospora phaseoli**, TN.

LEAF SPOT, White. **Pseudocercosporella albida**, MN.

LEAF SPOT, Zonate. **Cristulariella pyramidalis**, WV.

NEMATODE, Awl. **Dolichodorus heterocephalus**.

NEMATODE, Hop Cyst. **Heterodera humuli**, OR; **H. glycines**, soybean cyst, IL.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. hapla**; **M. incognita**; **M. javanica**; Root Lesion, **Pratylenchus pratensis**.

NEMATODE, Stubby Root. **Trichodorus christiei**.

NEMATODE, Stunt. **Tylenchorhynchus claytoni**.

NONPARASITIC. **Baldhead**. Mechanical injury to seed growing point.

Blossom Drop. High temperature, low humidity.

Bronze Leaf. Excessive salt concentration, CO, MT, WY.

Chlorosis. Deficiency of: Copper, FL; Magnesium, FL, MA, SC, VA; Manganese, FL; Zinc, CA, FL. Soil alkalinity, West.

Ozone Injury. Air pollution.

Seed Pitting. Plant bug injury.

Variegation. Genetic leaf abnormality.

Wind Whip.

POD SPOT, Seed Mold. **Cladosporium herbarum**, on lima bean, CA, FL.

POD SPOT, Yeast Spot. **Nematospora phaseoli**, on lima bean; **Pullularia pullulans**, NY.

POWDERY MILDEW. **Erysiphe polygoni**, East, South, CA: **Microsphaera diffusa**, GA, IL, MD; **M. euphorbiae**, IL.

ROT, Black Root. **Thielaviopsis basicola**, AL, CA, NH, NJ, NY.

ROT, Brown Stem. **Cephalosporium gregatum**, IL.

ROT, Root. **Fusarium solani** f. sp. **phaseoli**, general; **Phoma terrestris**, secondary, CA; **Phymatotrichum omnivorum**, AZ, OK; **Pythium aristorum**, WI; **P. catenulatum**, WI; **P. dissotocum**, WI; **Pythium** spp., widespread; **Aphanomyces eutiches**, NY.

ROT, Root and Stem; Web Blight. **Pellicularia filamentosa**, general.

ROT, Soft. **Rhizopus stolonifer** and **Pythium aphanidermatum**, leak, of market beans.

ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, general, especially in South and West; **S. minor**; **S. ricini**; **S. intermedia**, in market beans. **Pythium myriotylum**, FL, GA, SC; **Marasmius** spp., NE.

RUSSET. **Plectosporium tabacinum**, MD, NY.

RUST. **Uromyces phaseoli** var. **typica**, II, III, general; 0, I, rare; **U. appendiculatus** var. **appendiculatus** (= **U. phaseoli**), CO, NE; **Phakopsora pachyrhizi**, FL.

STEM NECROSIS, Decline. **Phytophthora capsici**, MI.

SPOT ANTHRACNOSE; Lima Bean Scab. **Sphaceloma phaseoli**, NC.

VIRUS. **Alfalfa Mosaic**, WA.

VIRUS. **Bean Common Mosaic**, ID, NY, WA; **Bean Common Mosaic Necrosis**, CA.

VIRUS. **Bean Mosaic**, general; **Southern Bean Mosaic**, CA, CO, LA, MD, MI; **Bean Pod Mottle**; **Bean Phyllody**; **Bean Red Node**; CO, ID, MS, WY; **Bean Yellow Mosaic**, ND; **Bean Yellow Stipple**, IL; **Bean Yellow Dot = Alfalfa Mosaic**, WA; **Beet Curly Top**, West; **Cucumber Mosaic**; **Tobacco Necrosis**; **Tobacco Ring Spot**; **Bean Golden Mosaic**, FL; **Cowpea Chlorotic Mottle**, IL; **Clover Proliferation Subgroup A Phytoplasma**, WA.

VIRUS. **Bromegrass Mosaic**, general, IA, SD, on Broad Bean (*Vicia fava* var. *minor*); **Clover Yellow Vein**, CA.

VIRUS. **Lettuce Mosaic**, NY.

VIRUS. **Lima Bean Mild Mottle**, GA.

VIRUS. **Potato Virus X**, work at the University of Wisconsin on *P. lathyroides*, *P. lunatus, P. aboriginens, P. vulgaris* "Pinto"; **Peanut Stunt**, AR; **Peanut Mottle**, WA.

WILT; Yellows. **Fusarium oxysporum** f. sp. **phaseoli**, CA, CO, ID, MT; **F. oxysporum** f. sp. **vasinfectum**, AL, FL.

Anthracnose and bacterial blight, often erroneously called "rust," are common and destructive bean diseases best avoided by purchasing healthy seed grown in disease-free arid sections of California and the Northwest. True rust is prevalent in the Southwest and sometimes in the East on susceptible Kentucky Wonder pole beans. Use resistant varieties; clean and disinfest poles each season.

Downy mildew is common on lima beans in moist summers. Resistant varieties are the best solution to virus problems. Avoid picking or cultivating beans when foliage is wet.

BEAN, MUNG (*Phaseolus aureus*)

ROT, Sprout. **Cylindrocephalum** sp., WA.

BEAN, SCARLET RUNNER (*Phaseolus coccineus*)

ANTHRACNOSE. **Colletotrichum lindemuthianum**, NY.
BACTERIAL Blight. **Xanthomonas phaseoli**, IN, NJ, TX.
BACTERIAL Halo Spot. **Pseudomonas phaseolicola**, NY.
LEAF SPOT. **Ascochyta boltshauseri**, OR; **Cercospora cruenta**, AL.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Root. **Fusarium solani** f. sp. **phaseoli**, NY.
RUST. **Uromyces phaseoli** (II, III), AL, MA, NH; **Phakopsora pachyrhizi**, FL.

BEAN, TEPARY (*Phaseolas acutifolius*)

BLIGHT, Southern. **Sclerotium rolfsii**, AL.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Root. **Fusarium solani**, CA; **Phymatotrichum omnivorum**, TX.
RUST. **Uromyces phaseoli** (II, III), CA, TX.
VIRUS. **Beet Curly Top**, CA.

BEAN, ASPARAGUS, YARDLONG (*Vigna sesquipedalis*)

BACTERIAL Spot. **Pseudomonas syringae**, IN, NY.
LEAF SPOT. **Mycosphaerella cruenta**, VA.

LEAF SPOT; Pod Spot. **Cladosporium vignae**, IN.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
VIRUS. **Potato Virus X**, work at the University of Wisconsin on *V. unguiculata* spp. *cylindrica* "Catjang," *V. unguiculata* spp.*sesquipedalis, V. unguiculata* spp. *unguiculata*.

BEAN, URD (*Vigna*)

BACTERIAL Leaf Spot; Stem Collapse. **Pseudomonas syringae** pv. **syringae**, ID.
VIRUS. **Cowpea Mosaic**, NY.

BEARBERRY (*Arctostaphylos uva-ursi*)

BLACK MILDEW. **Asterina gaultheriae**, WI; **A. conglobata**, ME.
GALL, Leaf; Red Leaf Spot. **Exobasidium vaccinii**, CO, ID, MA, MT, NJ, NY, VT, WI.
LEAF SPOT. **Cercospora gaultheriae**, WI.
RUST. **Chrysomyxa arctostaphyli** (III), AK, CO, MT, UT, WI; **Puccinia sparsum** (II, III), WI.

BEAUTY-BUSH (*Kolkwitzia*)

LEAF SPOT. **Cercospora kolkwitziae**, AL, OK.

BEECH (*Fagus*)

BROOMRAPE. **Conophilis americana**; **Epifagus virginiana**, beechdrops.
CANKER, Beech Bark Disease. **Nectria coccinea** var. **faginata**, associated with woolly beech scale, destructive northern New England and NY, OH; **N. galligena**, New England, MI, NY, NC, PA, WV; **Cryptococcus fagesuiga**, OH, VA.
CANKER, Bleeding. **Phytophthora cactorum**. MA, NY, RI.
CANKER; DIEBACK. **Cytospora** spp.; **Strumella coryneoides**, New England; **Phomopsis** sp., MI, NY, PA.
CANKER, Felt Fungus. **Septobasidium** spp.; **S. cokeri**, **S. curtisii**, FL, NC.
CANKER, Perennial. **Endothia gyrosa**, NY.

LEAF SPOT. **Cercospora** sp., NY; **Gloeosporium fagi**, CT to WI; **Microstroma** sp., IL, NJ; **Phyllosticta faginea**, MA to WV.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), occasional VT to IN and southward.

NONPARASITIC. **Leaf Scorch**, common in Northeast but cause unknown, associated with high temperature and water deficiency;
Leaf Mottle, cause unknown, virus suspected, CT, NJ, NY, PA.

POWDERY MILDEW. **Microsphaera alni**, MA to AL, WI; **Phyllactinia corylea**, New England to AL, IL, WI.

ROT, Heart, Butt, Wound. **Fomes** spp.; **Ganoderma applanatum**; **Polyporus** spp.; **Schizophyllum commune**; **Stereum** spp.

ROT, Mushroom Root. **Armillaria mellea**, CT, NJ, NY, OH.

ROT, Sapwood. **Hericium** spp.; **Ustulina deusta**.

ROT, Wood. **Daedalea** spp.; **Daldinia** spp.; **Lenzites betulina**, widespread.

SOOTY MOLD. **Scorias spongospora**, MA to AL, MO.

BEET (*Beta vulgaris*)

BACTERIAL, symtomless. **Clavibacter sepedonicum**, ND.

BACTERIAL Black Streak. **Pseudomonas syringae** pv. **aptata**, CA, OR, UT, WA.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, occasional.

BLIGHT, Foliage. **Thanatephorus cucumeris**, MN.

BLIGHT, Phytophthora. **Phytophthora**, IL.

BLIGHT, Southern. **Sclerotium rolfsii**, NC to FL, AZ, CA, TX.

DAMPING-OFF. **Pythium** spp.; **Rhizoctonia solani**, general.

DODDER. **Cuscuta** spp., occasional when beets follow legumes.

DOWNY MILDEW. **Peronospora schachtii**, CA, MN, NJ, NY, OR, WA.

LEAF SPOT. **Alternaria** sp., general, secondary; **Gloeosporium betae**, MS, MT; **Ramularia beticola**, CA, OR, WA; **Septoria betae**, DE, IN, MA, OH.

LEAF SPOT; Blight. **Cercospora beticola**, general.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, KS.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. javanica**; **M. chitwoodi**, Pacific NW; **M. hapla**, Pacific NW; Sugar-beet, **Heterodera schachtii**; Clover Cyst, **H. trifolii**; Gall, **Nacobbis batatiformis**.

NEMATODE, Sheath. **Hemicycliophora obtusa**. Sting, **Belonolaimus gracilis**; Stubby Root, **Trichodorus christiei**; Lesion, **Pratylenchus penetrans**.

NONPARASITIC. **Black Heart**. Boron deficiency, general; phosphorus deficiency, occasional.

Bronzing. Potassium deficiency occasional.

Chlorosis. Alkalinity, iron, manganese deficiency.

Girdle. Strangling constriction of tap root.

Tipburn. Black tips, from high nitrogen with low light intensity.

POWDERY MILDEW. **Erysiphe polygoni**, CA.

ROT, Black Heart. **Phoma betae**, general, occasional as leaf spot.

ROT, Black Root. **Aphanomyces cochlioides**, general.

ROT, Charcoal. **Macrophomina phaseoli**, CA.

ROT, Crown. **Sclerotinia sclerotiorum**, CT, IL.

ROT, Root. **Phytophthora drechsleri**, CA, CO, ID; **P. cryptogea**, WY; **Physalospora rhodina**, AL; **Phymatotrichum omnivorum**, TX; **Pythium deliense**, AZ, TX; **Rhizopus arrhizus**, WY; **Fusarium oxysporum** f. sp. **betae**, CO, MT.

ROT, Violet Root. **Helicobasidium purpureum**, occasional.

ROT, Wound, Storage. **Aspergillus fumigatus**, MI; **Rhizopus** spp., cosmopolitan; **Cylindrocarpon radicicola**, NY; **Penicillium** spp.; **Fusarium** spp.

RUST. **Puccinia aristidae** (0, I), CO, KS, NM, UT; II, III on grasses; **Uromyces betae** (II, III), AZ, CA, NM, OR.

SCAB. **Streptomyces scabies**, widespread.

SCAB, Acid. **Streptomyces acidiscabies**, ME.

VIRUS. **Beet Black Scorch**, CO; **Beet Curly Top**; **Beet Latent**; **Beet Mosaic**; **Beet Pseudo-Yellows**; **Beet Ring Mottle**; **Beet Savoy**; **Beet Yellow Net**; **Beet Yellows**; **Beet Yellow Vein**; **Cucumber Mosaic**; **Beet Necrotic Yellow Vein**, CA, NE, TX, WA; **Beet Necrotic Yellow Vein** (Vector, *Polymyxa beta*, **Rhizomania** disease), CA, MN, TX, WA; **Beet Western Yellows**, CA; **Lettuce chlorosis**, CA; **Lettuce Infectious Yellows**, AZ, CA; **Beet Distortion Mosaic**, CA; **Beet 2 Alphacryptovirus**; **Lettuce Speckles Mottle**, CA; **Beet Soilborne**; **Beet Soilborne Mosaic**, MN.

WHITE RUST. **Albugo bliti**, IA, OH.

WILT. **Verticillium albo-atrum**, CO.

WILT; Yellows. **Fusarium conglutinans** (**F. orthoceras**) var. **betae**; **F. graminearum** (sugar beets) MN, WY.

Most of the troubles are more important for commercially grown sugar beets. Cercospora leaf spot or blight is common on garden beets although spraying is not often practical. Boron deficiency can be prevented by treating soil with borax.

BEGGARWEED, FLORIDA (*Desmodium tortuosum*)

RUST. **Phakopsora pachyrhizi**, GA.

BEGONIA

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, MS, TX.

BACTERIAL Spot. **Xanthomonas begoniae**, general.

BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan.

LEAF SPOT, Anthracnose. **Gloeosporium** sp., FL, LA, MA, MS, NJ, TX; **Cercospora** sp., FL, GA, MS, NJ, TX; **Penicillium bacillosporium**, secondary; **Phyllosticta** sp., NJ, PA.

NEMATODE, Leaf. **Aphelenchoides fragariae**, cosmopolitan in greenhouses; Lesion, **Pratylenchus** sp.

NEMATODE, Root Knot. **Meloidogyne** spp., cosmopolitan in gardens in the South, greenhouses in the North.

NONPARASITIC. **Oedema**. A water-soaked spotting, frequent in house plants.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA; **Oidium** sp., CA, FL, NC; **Oidium begoniae**, OH.

ROT, Root. **Armillaria mellea**, CA; **Thielaviopsis basicola**, MA, OH.

ROT, Root and Stem. **Pythium** spp., CA, MO; **Rhizoctonia solani**, cosmopolitan; **Sclerotinia sclerotiorum**, CA: **Sclerotium rolfsii**, IL.

VIRUS. **Impatiens Necrotic Spot**, NC; **Tomato Spotted Wilt**, CA, MO, OK, TX; **Broad Bean Wilt**, MN.

WILT. **Verticillium albo-atrum**, CT, NY; **Fusarium foetens**, CT.

The dry air of the average living room keeps leaf diseases at a minimum. Overwatering may foster root rots and physiological oedema. In greenhouses Botrytis blight, bacterial spot, leaf nematode, and Pythium rots may become problems. Powdery mildew is serious on tuberous begonias.

BELLS-OF-IRELAND (*Molucella*)

LEAF SPOT. **Cercospora apii**, CA.
ROT, Crown. **Myrothecium** sp., TX.

BIDENS (*Bur-Marigold*)

BACTERIAL, MLO. **Aster Yellows**, CA.
POWDERY MILDEW. **Sphaerotheca macularis**, general.
RUST. **Uromyces bidenticola** (0, I, II, III), CA, FL, NM.
VIRUS. **Bidens Mottle**, FL.

BIGNONIA (*Crossvine*)

BLACK MILDEW. **Asterina bignoniae**, LA; **Meliola bidentata**, Gulf states; **M. furcata**, FL.
LEAF SPOT. **Cercospora capreolata**, AL, MS; **Leptostromella bignoniae**, TN.
NEMATODE, Root Knot. **Meloidogyne** sp.
SOOTY MOLD. **Capnodium elongatum**, AL, MS.
SPOT ANTHRACNOSE. **Sphaceloma** sp., LA.

BINDWEED, FIELD (Convolvulus)

POWDERY MILDEW. **Erysiphe convolvuli** var. **convolvuli**, General, N. America.

BIRCH (*Betula*)

ANTHRACNOSE. **Gloeosporium** sp.; **Glomerella cingulata**, VA, on Eur. White Birch.
CANKER, Bark Patch. **Aleurodiscus oakesii**, VT; **Solenia ochracea**, cosmopolitan.
CANKER, Bleeding, **Phytophthora cactorum**, NJ.
CANKER, Trunk. **Hymenochaete agglutinans**, MI, PA; **Nectria coccinea**; **N. galligena**; Twig Canker, **N. cinnabarina**.

DIEBACK. **Melanconis stilbostoma**, MA to IN on white birch; other species; **Cylindrosporium orthosporum**.

LEAF BLISTER. **Taphrina americana**, witches' broom, NH, VT, WI; **T. carnea**, ME, NH; **T. flava**, ME, MA, NH, WI.

LEAF SPOT. **Gloesporium betularum**; **G. betulae-luteae**, NY, PA; **Cylindrosporium betulae** DE, NY, WI; **Phyllosticta betulinum**; **Septoria betulicola**; **S. betulae**.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL, IN, TX; **Viscum album**, CA, on *Betula verrucosa* (Weeping White Birch).

POWDERY MILDEW. **Microsphaera alni**, MA, NH, PA; **Phyllactinia corylea**, widespread.

ROT, Heart. **Fomes** spp.; **Stereum purpureum**; **Polyporus hispidus**.

ROT, Root. **Armillaria mellea**; **Phytophthora cinnamomi**, of seedlings; **Phymatotrichum omnivorum**, TX.

ROT, Sapwood. **Polyporus betulinus**, general on gray and paper birches; **P. gilvus**; **Steccherinum** spp.

ROT, Wood. **Polyporus** spp., **Stereum** spp.; **Daedalea unicolor** and other spp.

ROT, Wound. **Schizophyllum commune**; **Pleurotus serotinus**.

RUST. **Melampsoridium betulinum** (II, III); 0, I on larch.

VIRUS. Dieback, vein clearing, New England.

BIRD-OF-PARADISE (*Strelitzia*)

BACTERIAL Leaf Spot; Blight. **Xanthomonas campestris**, FL.

BLIGHT. **Cylindrocladium clavatum**, FL.

BISCHOFIA

LEAF SPOT, Algal. **Cephaleuros virescens**, FL.

BISHOPS-CAP (*Mitella*)

LEAF SPOT. **Cercospora mitellae**, MI; **Phyllosticta mitellae**, NY, WI; **Ramularia mitellae**, IL, IN, MI, NY: **Septoria mitellae**, MI, WI.

POWDERY MILDEW. **Sphaerotheca macularis**, WI.

ROT, Leaf. **Sclerotium deciduum**, WI.

RUST. **Puccinia heucherae** (III), widespread.

BITTERCRESS (Cardamine)

ROT. **Sclerotinia minor**, NC.

BITTERSWEET (*Celastrus*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT.

CANKER; DIEBACK. **Glomerella cingulata**, NH, NC.

LEAF SPOT. **Ascochyta** sp., CT; **Asteria celastri**, KS, ME, MI; **Cercospora melanochaeta**, IA, KS, NE, ND; **Marssonina** sp., NY; **Phyllosticta celastri**, IL, KS, MA, NY, WV; **Ramularia celastri**, VT to MS, ND, TX.

POWDERY MILDEW. **Microsphaera alni**, WI; **Phyllactinia corylea**, ME to VA, SD, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.

BIXA (*Annato-Tree*)

LEAF SPOT. **Cercospora bixae**; **Phyllosticta bixae**.

LEAF SPOT. Algal. **Cephaleuros virescens**, FL.

BLACK BEARBERRY (*Arctous*)

RUST. **Pucciniastrum sparsum** (II, III), AK.

BLACKBERRY (*Rubus*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general; Cane Gall, **A. rubi**, NY, OR, PA, WA, WI; Hairy Root, **A. rhizogenes**, OR.

BLIGHT, Cane. **Gnomonia rubi**, ME, MD, NY, PA, VT; **Leptosphaeria coniothyrium**, NY to NC, TX, WI, Pacific Northwest.

BLIGHT, Spur. **Didymella applanata**, VA, WI.

BLIGHT, Stamen; Dry Berry. **Hapalosphaeria deformans**, OR, WA.

BLIGHT, Thread. **Pellicularia koleroga**, LA.

BLOTCH, Sooty. **Gloeodes pomigena**, MD to NC, IN, TX; **Geastrumia polystigmatis**, NC.

CANKER. **Glomerella cingulata**, MD, VA; **Phomopsis** sp., WA; **Botryosphaeria obtusa**, OH; **B. dothidea**, MD; **Leptosphaeria coniothyrium**, OH; **Gnomonia rubi**, OH.

CANKER, Cane Spot. **Ascospora ruborum**, WA.

DOWNY MILDEW. **Peronospora rubi**, MD, WI.

FRUIT SPOT; Fly Speck. **Leptothyrium pomi**, PA to NC, IL.

LEAF SPOT. **Mycosphaerella confusa**, VA to FL, IL, IN, TX; **M. rubi**, NC, WI; **Pezizella oenotherae**, also fruit rot, MD, OH, VA; **Cylindrosporium rubi**, NC, TX; **Phyllosticta** spp., FL, IL, NH; **Septoria darrowi**; **S. rubi**, general.

LEAF SPOT. Algal. **Cephaleuros virescens**, AR, FL, LA.

POWDERY MILDEW. **Sphaerotheca macularis**, CT to MD, IL, MN, Pacific Northwest; **Phyllactinia corylea**, MI.

ROSETTE, Double Blossom. **Cercosporella rubi**, NY to FL, CA, TX.

ROT, Gray Mold. **Botrytis cinerea**, general on fruit, bud, shoot.

ROT, Root. **Armillaria mellea**, TX, WA; **Phymatotrichum omnivorum**, TX; **Phytophthora dreschleri**, NC; **Rhizoctonia solani**.

ROT, White Root. **Corticium galactinum**, near apple trees, AR, MD, VA.

RUST, Orange. **Gymnoconia peckiana** (0, I, III), ME to GA and west to Pacific; **Kunkelia nitens** (I), general, more common in South; **Phragmidium violaceum**.

RUST, Yellow Cane. **Kuehneola uredinis** (0, I, II, III), ME to FL, LA, WI.

SPOT ANTHRACNOSE. **Elsinoë veneta**, general.

VIRUS. **Blackberry Dwarfing**; **Blackberry Mosaic**; **Blackberry Variegation**; **Loganberry Dwarf**, OR; **Raspberry Beta-Leaf Curl**; **Red Raspberry Mosaic**, MA to VA, IA, WI, Pacific Northwest; **Raspberry Ringspot**; **Raspberry Streak**, OH, PA, WA; **Tobacco Streak**, OR, WA; **Wineberry Latent**; **Beet Pseudo-Yellows**, AR, NC, SC.

WILT. **Verticillium albo-atrum**, CA, MN, NY, WA.

Sanitation is the best approach to home garden blackberry diseases. Plants with crown gall, orange rust, or virus diseases should be removed and burned, replanting with clean stock.

BLACKBERRY- LILY (*Belamcanda*)

LEAF SPOT. **Alternaria** sp., KS, VA; **Didymellina macrospora**, CA, IA, KS, NY OK, VT, VA.

RUST. **Puccinia iridis**, FL.
VIRUS. **Tomato Spotted Wilt**, FL.

BLADDER-SENNA (*Colutea*)

BLIGHT, Twig. **Diplodia coluteae**, PA.
POWDERY MILDEW. **Erysiphe polygoni**.
ROT, Root. **Ganoderma** sp., OK; **Phytophthora cactorum**, MO.
RUST. **Uromyces colutea** (II, III), KS.

BLANKET FLOWER (*Gaillardia grandiflora*)

POWDERY MILDEW. **Leveillula taurica**, WA.

BLEEDING-HEART (*Dicentra spectabilis*)

ROT, Stem. **Sclerotium rolfsii**, NY; **Sclerotinia sclerotiorum**, MN.
VIRUS. **Tobacco Rattle**, MA, MI, MN.
WILT. **Fusarium** sp., NJ.

BLEEDING-HEART VINE (*Clerodendrin*)

VIRUS. **Zonate Ring Spot**, FL.

BLEPHILIA

LEAF SPOT. **Cercoseptoria blephiliae**, WI; **Septoria menthicola**, WI.
RUST. **Puccinia menthae** (0, I, II, III), IL, IN, IA, MD, MI, MO, TN, WI.

BLOODROOT (*Sanguinaria*)

BLIGHT, Gray Mold. **Botrytis cinerea**, NY.
LEAF SPOT. **Cercospora sanguinariae**, MD, MO, NY, PA, TX, WI; **Cylindrosporium circinans**, MD, MO, WI; **Gloeosporium sanguinariae**, OH, TX; **Phyllosticta sanguinariae**, MO, TX, WV.

BLUEBERRY (*Vaccinium*)

ANTHRACNOSE. **Gloeosporium** sp., FL, NJ.

BACTERIAL Canker. **Pseudomonas** sp., OR; **Xanthomonas campestris** pv. **maniotis** (also leaf spot), FL; **X. campestris** pv. **fici** (also leaf spot), FL.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MA, MI, WA.

BLACK MILDEW, **Meliola nidulans**, AL, GA.

BLIGHT, Blossom, Fruit, Twig. **Botrytis cinerea**, CA, ME, MA, NJ, OR, WA; **Diaporthe vaccinii**, ME, MA, NJ.

BLIGHT, Stem. **Botryosphaeria dothidea** (*B. ribis*), NC; **Phomopsis vaccinii**, NC.

CANKER, Blight of Stem, MI. **Glomerella cingulata**, **Alternaria** sp., **Sordaria** sp., **Epicoccum** sp., **Tympanis** sp., **Papulospora** sp., **Nectria cinnabarina**, **Coniothyrium** sp., **Pestalotia** sp., **Verticillium** sp., **Godronia cassandrae** f. sp. **vaccinii**, **Phoma** sp., **Dendrophoma** sp., **Diaporthe** (**Phomopsis**) **vaccinii**, **Melanospora** sp., **Pullularia** spp., **Coryneum microstictum**, **Sphaeronema** sp., **Fusarium** spp., **Bispora** sp., **Botrytis cinerea**, **Cephalosporium** sp., **Cylindrocarpon** sp., **Pyrenochaeta** sp.

CANKER, Cane. **Physalospora corticis**, AL, FL, MS, NC; **Godronia cassandrae**, ME, MI; **Botryosphaeria corticis**, AL, FL, GA, MS, NC; **Coryneum microstictum**, MA, MI.

CANKER, Twig. **Dothidella vacciniicola**, NC; **Fusicoccum putrefaciens**, ME, MA, MI, **Phomopsis vaccinii**, MI.

DODDER. **Cuscuta** sp., FL.

GALL, Red Leaf. **Exobasidium vaccinii**, also fruit green spot, general; **Synchytrium vaccinii**, ME, MS.

LEAF SPOT. **Gloeocereocospora inconspicua**, GA, MD, NC; **Phyllosticta** sp., AL, GA; **Phyllostictina vaccinii**, GA, MD, MI, NC; **Piggotia vaccinii**, WI; **Discohainesia oenotherae**, NJ, NC; **Ramularia vaccinii**, FL, MD, MI, NJ, NY; **Septoria albopunctata**; **Alternaria tenuissima**, NC; **Cristulariella pyramudates**, MD.

LEAF SPOT, Double Spot. **Dothichiza caroliniana**, GA, NC.

LEAF SPOT, Tar. **Thytisma vaccinii**, widespread.

NEMATODE. **Helicotylenchus** sp.; **Hemicycliophora similis**; **Merlinius joctus**; **Xiphinema americanum**.

POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, widespread.

ROT, Berry; Dieback. **Alternaria** sp., MA, NJ, NC; **Glomerella cingulata**, NJ, NY; **Phomopsis vaccinii**, NC.

ROT, Brown; Mummy Berry. **Monilinia vaccinii-corymbosi**, IN, ME, MA, MI, NJ, NY, NC, PA.

ROT, Root. **Phytophthora cinnamomi**, AR, NJ, VA; **P. nicotainae**, VA; **P. palmivora**,VA.

RUST, Witches' Broom. **Pucciniastrum goeppertianum** (III) ME to MN; 0, I on fir; Leaf, **P. myrtilli** (II,III) ME to PA,WI; 0, I, spruce.

VIRUS. **Blueberry Necrotic Ring Spot**; **Blueberry Red Ring Spot**; **Blueberry Stunt**, MA, MI, NJ, NY, NC; **Blueberry Shoestring**, MI, NJ, WA; **Blueberry Leaf Mottle**, MI; **Blueberry Necrotic Shock**, OR, WA; **Blueberry Scorch**, CT, MA, OR, WA, British Columbia, Canada.

VIRUS. **Tobacco Ring Spot**, IL; **Peach Rosette Mosaic**, MI.

BLUE COHOSH (*Caulophyllum*)

BLIGHT, Leaf. **Botrytis streptothrix**, NJ, NY.

LEAF SPOT. **Cercospora caulophylli**, VT to VA, MO, WI.

BLUE CURLS (*Trichostema*)

LEAF SPOT. **Septoria trichostematis**, NY.

BLUE-EYED GRASS (*Sisyrinchium*)

BLIGHT, Leaf. **Kellermania sisyrinchii**, CA, NM, ND.

NEMATODE, Lesion. **Pratylenchus pratensis**.

RUST. **Uromyces houstoniatus** (II, III), ME, WV; 0, I on *Houstonia* spp.; **U. Probus** (I, II, III), ID, OR, TX, UT, WA; **Aecidium residuum** (0, I), OK, TX.

BLUE LACE-FLOWER (*Trachymene*)

BACTERIAL, MLO. **Western Aster Yellows**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

ROT, Root and Stem. **Fusarium** sp., CT, NJ; **Rhizoctonia solani**, NJ.

WILT. **Phytophthora cactorum**, MA.

BLUESTEM, BIG (*Andropogon*)

LEAF SPOT. **Ascochyta brachypodii**, NY, PA; **Phyllosticta andropogonivora**, MN, ND, SD.
VIRUS. **Barley Yellow Dwarf**.

BLUESTEM, LITTLE (*Schizachyrium*)

VIRUS. **Barley Yellow Dwarf**.

BOEHMERIA

NEMATODE. **Paratylenchus elachistus**, FL.

BOISDUVALIA

RUST. **Puccinia glabella** (II, III), NV, OR, UT; 0, I unknown; **P. oenotherae** (0, I, II, III), CA, ID, NV, OR, WA; **P. vagans** var. **epilobi-tetragoni** (0, I, II, III), CA, ID, NV, OR, UT.

BOLTONIA

LEAF SPOT. **Septoria erigerontis** var. **boltoniae**, IA, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, SD.
RUST. **Puccinia dioicae** var. **asteris** (II, III), IA, NE, ND, SD; 0, I on sedge; **Uromyces compactus** (0, I, II, III), TX.
SMUT, White. **Entyloma compositarum**, WI.

BORAGE (*Borago*)

LEAF SPOT. **Ramularia** sp., CA; **Stemphylium** sp.
ROT, Soft. **Sclerotinia sclerotiorum**, ND.

BOTTLE-BRUSH (*Callistemon*)

LEAF SPOT. **Cylindrocladium colhounii**, FL, HI, LA, NC, OR, SC; **C. clavatum**, FL.
ROT, Root. **Armillaria mellea**, CA.

BOUGAINVILLEA (*Buginvillaea*)

BACTERIAL Leaf Spot. **Pseudomonas andropogonis**, FL; **Burkholderia andropogonis**, Canada.
BLIGHT, Foliage. **Phytophthora parasitica**, FL.
LEAF SPOT. **Cladosporium arthrinioides**, TX; **Cercospora bougainvilleae**, FL.
VIRUS. **Mosaic**. Undetermined, FL.

BOUVARDIA

NEMATODE, Leaf. **Aphelenchoides fragariae**.
NEMATODE, Root Knot. **Meloidogyne** sp., NY.
RUST. **Puccinia bouvardiae** (0, I, III), AZ.

BOYSENBERRY

Subject to most blackberry diseases: anthracnose, crown gall, cane gall, cane canker, dieback, leaf spots, mosaic.

BOXELDER (*Acer negundo*)

ANTHRACNOSE. **Gloeosporium apocryptum**, widespread.
BACTERIAL Leaf Spot. **Pseudomonas aceris**, CA.
BLIGHT Leaf. **Coryneum negundinis**, MO; on twigs, ME.
BLIGHT, Twig. **Coniothyrium negundinis**, IL, OK; **Coryneum negundinis**, ME. **Nectria cinnabarina**.
CANKER, Felt Fungus. **Septobasidium** spp., NC.
LEAF SPOT. **Alternaria** sp.; **Ascochyta negundinis**, IL, NC: **Cercospora negundinis**, KS, NE, WI; **Piggotia negundinis**, WI; **Phyllosticta minima**, general; **P. negundinis**, ME to AL, TX, WI; **Septoria aceris**, general; **S. negundinis**; **Cylindrosporium negundinis**; **Cristulariella pyramidalis**.
LEAF SPOT, Tar. **Rhytisma punctatum**, CA, NY; **R. acerinum**, OR, WA.
POWDERY MILDEW. **Phyllactinia corylea**, SD: **Microsphaera alni**, **Uncinula circinata**.

ROT, Root. **Phymatotrichum omnivorum**, CA, TX; **Helicobasidium purpureum**, TX.

WILT. **Verticillium albo-atrum**, occasional.

BOXWOOD (*Buxus*)

BLIGHT, Leaf Cast. **Hyponectria buxi**, general; **Verticillium buxi**, cosmopolitan on dead leaves, often associated with *Hyponectria*.

BLIGHT, Leaf Tip. **Phoma conidiogena**, MD, NJ, NY, OK.

CANKER, "Nectria"; Leaf Blight. **Volutella buxi**, general; considered imperfect stage of *Pseudonectria rouselliana* but unconfirmed connection.

CANKER; DIEBACK. **Fusarium buxicola** (*Nectria desmazierii)*, AL, MD, PA; **F. lateritium** (see *Gibberella baccata*), secondary, MD, SC, VA.

LEAF SPOT. **Phyllosticta auerswaldii**, MD, MA, NJ, NY, VA, WA; **Macrophoma candollei**, prominent, general on dead leaves following winter injury or disease.

NEMATODE, Dagger. **Xiphinema americanum**.

NEMATODE, Lesion. **Pratylenchus pratensis**; **P. vulnus**, NC.

NEMATODE, Root Knot. **Meloidogyne hapla**; **M. incognita**; **M. incognita acrita**; **M. javanica**; **M. arenaria**, NC.

NEMATODE, Spiral. **Helicotylenchus nannus**; **Rotylenchus buxophilus**.

NEMATODE, Stubby Root. **Trichodorus** sp.

NONPARASITIC. **Freezing**. Ice standing on stems causes bark to slough off and branches die back for months thereafter.

Sunscald. Injury in late winter or early spring when covering is removed in bright sun or high wind.

ROT, Root. **Armillaria mellea**, NJ; **Fusarium oxysporum** and **F. solani**, MD, perhaps secondary; **Phymatotrichum omnivorum**, TX; **Phytophthora parasitica**, MD, NC; **P. cactorum**, NC; **P. citrophthora**, NC; **Pythium** sp., MA; **Rhizoctonia solani**, cosmopolitan after nematode injury.

ROT, Heart; Trunk. **Ganoderma lucidum**, VA; **Fomes igniarius**, VA; **Poria punctata**, VA.

ROT, Root; Decline. **Paecilomyces buxi** and some **Fusaria**, VA.

VIRUS. **Variegation**, cause unknown, MD, NY, VA.

Salmon-pink pustules appearing on backs of leaves, along twigs, and on main stems are indications of *Volutella buxi*, controlled by thorough cleaning, then

spraying. Much of the dieback, bronzing, general unhealth of boxwood is due to nematodes, especially spiral and root lesion or meadow.

BRACHIARIA (Broadleaf signalgrass)

ROT, Root. ***Pythium arrhenomanes***, LA.

BRACHYCOME (Swan River Daisy)

BACTERIAL, MLO. **Western Aster Yellows**, CA.
VIRUS. **Tomato Spotted Wilt**, PA.

BRACHYPODIUM (Slender False-Brome)

ANTHRACNOSE. **Colletotrichum graminicola**, MD.
BACTERIAL Spot. **Pseudomonas coronafaciens** var. **atropurpurea**, ND.
ROT, Root. **Curvularia geniculata** and **Fusarium scirpi**, secondary, ND.

BRICKELLIA (Brickle-Bush)

DODDER, **Cuscuta exaltata**, TX.
LEAF SPOT. **Cercospora coleosanthi**, CA, CO.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Aecidium arcularium** (0, I), AZ, CO, NM; **Coleosporium aridum** (II), CA; **Puccinia kuhniae**, AZ, FL; **P. subdecora** (0, I, II, III), AZ, CO, NM, UT; **Uredo arida** (II), CA.

BRISTLEGRASS (*Setaria*)

BLIGHT. **Beniowskia sphaeroidea**, GA, TX.
VIRUS. **Foxtail Mosaic**.

BROCCOLI

► Cabbage.

BRODIAEA

RUST. **Puccinia carnegiana** (0, I, III), AZ; **P. dichelostemmae** (0, I, III), CA, OR, WA; **P. moreniana** (III), CA; **P. nodosa** (0, I, II, III), CA; **P. pattersoniana**, ID, UT, WA; II, III on grasses; **P. subangulata** (0, I, III), WA; **Uromyces brodiaeae** (0, I, III), CA, OR, WA.

BROMEGRASS, Smooth (*Bromus*)

BACTERIAL Halo Blight. **Pseudomonas syringae** pv. **coronafaciens**, AK.
POWDERY MILDEW. **Blumeria graminis**, **Erysiphe graminis**, PA.
RUST. **Puccinia recondita**, PA.

BROMELIA

LEAF SPOT. **Gloeosporium** sp., FL, MD; **Helminthosporium rostratum**, FL.

BROOM (*Cytisus*)

CANKER. **Diaporthe** spp., NJ, NY; **Dothidea tetraspora**, CA; **Gloeosporium** sp., NJ; **Nectria coccinea**, OR; **Pestalotia polychaeta**, CA; **Phomopsis** sp., MA, NJ; **Physalospora obtusa**, AL. Many are secondary.
NEMATODE, Lesion. **Pratylenchus pratensis**.
ROT, Root. **Thielaviopsis basicola**, WI.

BROOM, SPANISH (*Spartium*)

CANKER. **Diplodia sarothamni**, CA; **Pestalotia polychaeta**, CA; **Phomopsis sarothamni**, CA. All possibly secondary infections.

BROUSSONETIA (Paper-Mulberry)

CANKER; DIEBACK. **Nectria cinnabarina**, AL, NY; **Fusarium solani**, OH.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
NEMATODE, Root Knot. **Meloidogyne** sp., MD.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Armillaria mellea**, CA.

BROWALLIA (*Streptosolen jamesonii*)

BACTERIAL Canker; Vascular. **Clavibacter michiganense**, WY.
NEMATODE, Root Knot. **Meloidogyne** sp.
VIRUS. **Tomato Spotted Wilt**, CA, OK.
WILT. **Fusarium** sp., DE.

BRUNFELSIA

BACTERIAL Canker; Vascular. **Clavibacter michiganense**, WY.

BRUSSELS SPROUTS

► Cabbage.

BRYONOPSIS

BACTERIAL Spot. **Pseudomonas lachrymans**, WI.
DOWNY MILDEW. **Pseudoperonospora cubensis**, MA, OH.

BUCKEYE

► Horse-Chestnut.

BUCKLEYA

RUST. **Cronartium comandrae** (II, III), TN; 0, I on pine.

BUCKTHORN (*Rhamnus*)

LEAF, Black. **Phytophthora ramorum**, CA.
LEAF SPOT. **Cercospora aeruginosa**, MO, NE, SC; **C. Bacilligera**; **C. rhamni**, LA, NE, NJ, TX, WI; **Cylindrosporium rhamni**, ID; **Marssonina rhamni**, WA; **Phaeosphaerella rhamni**, CA; **Phyllosticta rhamnigena**; **Septoria blasdalei**, CA, ID, OR, TX.
POWDERY MILDEW. **Microsphaera alni**, WI.

ROT, Heart. **Daedalea unicolor**, WA; **Fomes igniarius**, ID.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia coronata** (0, I), widespread; II, III on grasses, cereals, widespread; **P. mesneriana** (III), CA.
SOOTY MOLD. **Capnodium** sp., CA.

BUCKWHEAT-TREE (*Cliftonia*)

BLACK MILDEW. **Morenoella cliftoniae**, MS.
LEAF SPOT. **Coccomyces** sp.; **Pestalotia cliftoniae**, MS.

BUDDLEIA (Butterfly-Bush)

CANKER, Stem. **Phomopsis buddleiae**, AZ.
NEMATODE, Root Knot. **Meloidogyne** spp., AL, MS, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
SCAB. **Cladosporium heugelinianum**, DE, VA.
VIRUS, Line Spot. **Tomato Ringspot**, SC.

BUFFALOBERRY (Shepherdia)

DAMPING-OFF. **Pythium ultimum**, NE; **Rhizoctonia solani**, NE.
LEAF SPOT. **Septoria shepherdiae**, AK, ID, MT, UT, WI; **Cylindrosporium** sp., Great Plains.
POWDERY MILDEW. **Phyllactinia corylea**, UT; **Sphaerotheca macularis** (*S. humilis*); AK, CO, MT, TX, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, White Heart. **Fomes fraxinophilus**, CO, MT, NM, SD, WY.
RUST. **Puccinia caricis-shepherdiae** (0, I), Rocky Mts., AK, MI, NY, OR, WA; II, III on *Carex*; **P. coronata** (0, I), SD to NM, AK, WA.

BUFFALOGRASS (*Buchloe*)

SMUT. **Tilletia buchloëana**, KS, NE, OK, TX.

BUGLEWEED (*Ajuga*)

BLIGHT, Southern; Crown Rot. **Sclerotium rolfsii**, CA, CT, KS, NJ, NY. Serious in warm, muggy weather.
NEMATODE, Southern Root Knot. **Meloidogyne incognita**, GA.
ROT, Crown and Root. **Phoma** sp. GA.
VIRUS. **Cucumber Mosaic**, OH; **Tobacco Streak**, OH.

BUMELIA

LEAF SPOT. **Cercospora lanuginosa**, TX; **Phyllosticta bumeliifolia**, AL, TX; **P. curtisii**, FL, MO; **Septoria bumeliae**, MS.
ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.

BUNCHFLOWER (*Melanthium*)

LEAF SPOT. **Septoria allardii**, VA.
RUST. **Puccinia atropuncta** (II, III), NC, TN, VA.

BUNDLEFLOWER (*Desmanthus*)

LEAF SPOT. **Cercospora desmanthi**, KS, LA, MO, NM, SD, TN.
POWDERY MILDEW. **Erysiphe polygoni**, IL, MS.
RUST. **Ravenelia texensis** (II, III), TX.

BURNET (*Sanguisorba*)

LEAF SPOT. **Graphium sessile**, NY; **Ovularia bulbigera**, AK, IL.
POWDERY MILDEW. **Podosphaera oxyacanthae**, IA; **Sphaerotheca macularis**, AK, MA, NY, PA.
RUST. **Xenodochus carbonarius** (I, III), AK; **X. minor**, AK.

BUTTERFLY FLOWER (*Schizanthus*)

ANTHRACNOSE. **Colletotrichum schizanthi**, NY.
BACTERIAL, MLO. **Aster Yellows**, NJ.

BACTERIAL Canker; Vascular. **Clavibacter michiganense**, WY.
DAMPING-OFF; Root Rot. **Pythium ultimum**, MO; **Rhizoctonia solani**, NY.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Stem. **Sclerotinia sclerotiorum**, MS, MO.
VIRUS. **Tomato Spotted Wilt**, TX.

BUTTERFLY PEA (*Centrosema*)

LEAF SPOT. **Cercospora clitoriae**, AL; **Colletotrichum** sp., on pods.

BUTTERFLY PEA (*Clitoria*)

LEAF SPOT. **Cercospora clitoriae**, AL, FL; **C. cruenta**, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.

BUTTERFLY WEED (*Asclepias*)

BACTERIAL Blight. **Xanthomonas campestris** pv. **asclepiadis**, NE.
BLIGHT, Stem. **Phoma asclepiadea**, UT.
LEAF SPOT. **Cercospora asclepiadorae**, AL, TX; **C. clavata**, general; **C. venturioides**, WA; **Phyllosticta tuberosa**, IL, NJ.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia bartholomaei** (0, I), ND, SD; II, III on *Spartina*; **Uromyces asclepiadis** (II III), widespread.

BUTTONBUSH (*Cephalanthus*)

BLIGHT, Leaf. **Cercospora perniciosa**, TX.
BLIGHT, Thread. **Pellicularia koleroga**, FL.
DODDER. **Cuscuta compacta**, FL; **C. gronovii**, NY.
LEAF SPOT. **Ascochyta cephalanthi**, LA: **Coniothyrium cephalanthi**, LA; **Phyllosticta cephalanthi**, TX; **Ramularia cephalanthi**, AL, KS, LA, NY, WI; **Septoria cephalanthi**, KS, WI.
POWDERY MILDEW. **Microsphaera alni**, widespread. **Phyllactinia corylea**, IN.

RUST. **Puccinia seymouriana** (0, I), New England to FL and central states; II, III on *Spartina*, **Uredo cephalanthi** (II), FL.

CABBAGE (*Brassica oleracea*) (Including Broccoli, Brussels Sprouts, Cauliflower, Kale, Kohl-rabi)

BACTERIAL Black Rot. **Xanthomonas campestris**, general.

BACTERIAL Blight. **Pseudomonas syringae**, CA; **P. syringae** pv. **alisalensis**, CA.

BACTERIAL Leaf Spot. **Pseudomonas maculicola**, widespread; **P. cichorii**, FL and in market; **Xanthomonas campestris** pv. **armoraciae**, FL, OH; **Pseudomonas syringae** pv. **maculicola**, CA, OH, SC.

BACTERIAL, MLO. Western **Aster Yellows Phytoplasma**, CA, TX.

BACTERIAL Soft Rot; Stump Rot; **Erwinia carotovora**, cosmopolitan.

BLACKLEG; Leaf Spot. **Phoma lingam**, general east of Rocky Mts., also OR, WA.

BLIGHT, Gray Mold. **Botrytis cinerea**, FL; Pacific states, frequent.

BLIGHT, Southern. **Sclerotium rolfsii**, NC to FL, TX, occasional.

CANKER, Stem. **Botrytis cinerea**, WA.

CLUB ROOT. **Plasmodiophora brassicae**, general.

DAMPING-OFF; Bottom Rot. **Pythium** spp.; **P. polymastum**, CA; **Rhizoctonia solani**, general.

DOWNY MILDEW. **Peronospora parasitica**, general.

LEAF SPOT, Gray. **Alternaria brassicae**, general; Black Spot, Head Browning, **A. brassicicola**, general; **A. oleraceae**, occasional; **Cercospora brassicola**, CA, DE, FL, IL, MS, NC, OK; **Phyllosticta brassicicola**, CA; **Leptosphaeria maculans**, WI.

LEAF SPOT; White Spot. **Cercosporella brassicae**, IN, OR, PA; Ring Spot, **Mycosphaerella brassicicola**, AL, CA, IL, NY, OR, TX, WA; **Pseudocercosporella capsellae**, CA.

MOLD, Leaf. **Heterosporium variabile**, MT, NY; Seed, **Curvularia geniculata**; **Stemphylium botryosum**.

NEMATODE. **Nacobbis batatiformis**.

NEMATODE, Cabbage Cyst. **Heterodera cruciferae**. Sugar-Beet, **H. schachtii**.

NEMATODE, Lesion. **Pratylenchus pratensis**. Sting, **Belonolaimus gracilis**; **B. longicaudatus**; Stubby Root, **Trichodorus christiei**.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. javanica**.

NONPARASITIC. **Brown Heart**. Probably boron deficiency.
Chlorosis. Magnesium or manganese deficiency.
Oedema. Excessive water tension, or copper sprays.
Pink Head. Probably genetic.
Tipburn. Potassium deficiency.
Whip-tail. Spindly growth, failure to head, due to acid soil, mineral deficiencies.

POWDERY Mildew. **Erysiphe polygoni**, AZ, CA, CT, FL, MD, MA, OR; **E. cruciferarum**, CA.

ROT, Cottony; Drop. **Sclerotinia sclerotiorum**, AZ, MA, NY, TX.

ROT, Firm Head. **Sclerotinia sclerotiorum**, CA, NY; **Phytophthora porri**, WI.

ROT, Head. **Fusarium avenaceum**, NY.

ROT, Root. **Macrophomina phaseoli**, CA. on *Brassica campestris*.

ROT, Root. **Phymatotrichum**, TX; **Phytophthora megasperma**, CA, OR.

ROT, Root and Crown. **Sclerotinia minor**, CA.

ROT, Root; Damping-off. **Aphanomyces raphani**, WI. Also: **Brassica alboglabra**–Chinese Kale; **B. carinata**–Abyssinian Mustard; **B. napus**–;Rape; **B. perviridis**–Spanish Mustard; **B. robertiana**; **Eruca sativa**–Racuet Salad; **Raphanus raphanistruno**–Wild Radish.

ROT, Soft; Black Mold. **Rhizopus stolonifer**, occasional.

ROT, Sprout. **Alternaria tenuis**, **Rhizoctonia solani**, and **Fusarium** sp. on brussels sprouts.

VIRUS. **Cabbage Ring Necrosis**; **Cauliflower Mosaic**, GA; **Turnip Mosaic**, GA; **Beet Curly Top**; **Tomato Spotted Wilt**; **Cabbage Leaf Curl**, GA.

WHITE RUST; Blister. **Albugo candida**, CA, ID, KY, NE, NC, OH, TX.

WILT, Yellows. **Fusarium oxysporum** f. sp. **conglutinans**, general.

WILT, Vascular. **Verticillium dahliae**, CA.

A general control program starts with choosing varieties resistant to Fusarium yellows, purchasing disease-free seed or having it hot-water treated against blackleg and black rot, growing in soil free from club root and careful cleaning up of all vegetable refuse at the end of the season.

CACTUS (*Cereus*)

ANTHRACNOSE. **Mycosphaerella opuntiae**, TX.

BACTERIAL Soft Rot. **Erwinia carotovora**, TX.

BLIGHT, Gray Mold; Rot. **Botrytis cinerea**, occasional when too damp, indoors.
LEAF SCORCH. **Hendersonia opuntiae**, TX.
LEAF SPOT, Black. **Diplotheca** (*Stevensea*) **wrightii**, TX; Stem, **Septoria cacticola**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp.
NEMATODE, Cyst. **Heterodera cacti**; **Nacobbis batatiformis**.
ROT, Stem and Branch. **Aspergillus alliaceus**, TX; Dry Rot, **Poria** sp., CA.
ROT, Root and Stem. **Fusarium oxysporum**, AZ, CA; **Helminthosporium cactivorum**, CA, TX; **Phymatotrichum omnivorum**, TX.

CACTUS (*Leuchtenbergia principis and Schlumbergera gaertneri* "Makoyana")

NEMATODE, Cyst. **Heterodera cacti**.
VIRUS. **Tomato Spotted Wilt**, PA.

CACTUS, FISHHOOK, PINCUSHION (*Mammillaria*)

ANTHRACNOSE; Zonate Spot. **Gloeosporium cactorum**; **Mycosphaerella opuntiae**; Spine Spot, **Phoma mammillariae**, MT.
NEMATODE, Root Knot. **Meloidogyne incognita**, Bermuda Bot. Gard; **Meloidogyne** sp., TX; Cyst, **Heterodera cacti**.
ROT, Root. **Phymatotrichum omnivorum**, TX.

CACTUS, GIANT, SAGUARO (*Carnegiea*)

BACTERIAL Blight. **Erwinia carnegieana**, AZ.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, AZ.
ROT, Dry. **Poria carnegieae**; Heart, **Fomes robustus**.
ROT, Seedling. **Fusarium solani**; **F. oxysporum**.
VIRUS. **Saguaro Cactus**, AZ.
The bacterial blight is spread over the whole giant cactus area in Arizona, with mortality heaviest in magnificent specimens 150 to 200 years old.

CACTUS, PRICKLY PEAR (*Opuntia*)

ANTHRACNOSE; Zonate Spot. **Gloesporium cactorum**, FL, MS; Black Rot, **Mycosphaerella opuntiae**, AL, FL, LA, NY, SC, TX.
BACTERIALRot. **Erwinia aroideae**, FL, MS, OK, TX.
BLACK MILDEW. **Lembosia cactorum**, FL.
LEAF SCORCH. **Hendersonia opuntiae**, AL, KS, MT, NJ, TX.
LEAF SPOT, Black. **Diplotheca wrightii**, FL, TX.
NEMATODE, Root Knot. **Meloidogyne** sp.
NONPARASITIC. **Oedema**, causing glassiness or scab, from overwatering.
ROT, Charcoal. **Macrophomina phaseoli**, TX.
ROT, Cladode. **Aspergillus alliaceus**, TX; **Diplodia opuntiae**, MD, KS, PA; **Physalospora obtusa**, NY; **P. rhodina**, FL; **Phyllosticta cacti**, NM; **P. concava**, MO, NJ, OK, TX; **Septoria fici-indicae**, TX.
ROT, Root. **Armillaria mellea**, CA.
ROT, Stem. **Phytophthora parasitica**, NY; **Pythium debaryanum**, CA.
VIRUS. **Mosaic**, MD; **Chlorotic Ring Spot**, AZ, CA, ID, MT, NM, UT, WA, WY; **Opuntia Sammons**, AZ; **Tomato Spotted Wilt**, PA.

CACTUS, STAR, SEA-URCHIN, BARREL (*Echinocactus*)

ANTHRACNOSE. **Mycosphaerella opuntiae**, TX.
LEAF SCORCH; Scald. **Hendersonia opuntiae**, TX.
LEAF SPOT, Black. **Diplotheca** sp., TX.
ROT, Root. **Phymatotrichum omnivorum**, TX; Stem, **Aspergillus alliaceus**, TX.

CAESALPINIA

ANTHRACNOSE. **Gloeosporium** sp., FL.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, FL.
CANKER; DIEBACK. **Botryosphaeria ribis** var. **chromogena**, FL, TX.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Ravenelia humphreyana** (II, III), FL.

CALADIUM

BACTERIAL Soft Rot. **Erwinia carotovora**, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.

BLIGHT; Tuber Rot. **Botrytis ricini**, FL.
LEAF SPOT. **Gloeosporium thuemenii**, FL.
NEMATODE, Citrus. **Tylenchulus semipenetrans**, FL.
NEMATODE, Lesion. **Pratylenchus** sp., FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL, MS; **M. javanica**.
ROT, Tuber. **Fusarium solani**, FL.

CALATHEA

LEAF SPOT. **Glomerella cincta**, NJ; **Phyllosticta** sp.; **Alternaria alternata**, FL; **Drechslera setariae**, FL.
NEMATODE, Burrowing. **Radopholus similis**, FL. Spiral, **Helicotylenchus nannus**.

CALCEOLARIA (Slipperwort)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
NEMATODE, Leaf. **Aphelenchoides fragariae**.
NONPARASITIC. **Boron Deficiency**, leaf necrosis, CA.
ROT, Root. **Pythium mastophorum** and **P. ultimum**, CA.
ROT, Stem. **Sclerotinia sclerotiorum**, NY, WA.
VIRUS. **Tomato Spotted Wilt**, CA.
WILT. **Verticillium albo-atrum**, NY, WA.

CALENDULA (Pot Marigold)

BACTERIAL, MLO. **Aster Yellows**, CT, DE, ME, NJ, PA, VA; **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, MO, NJ, NY.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Alternaria** sp., NY; **Cercospora calendulae**, PA, TX, VA; **Colletotrichum gloeosporioides**, VA.
NEMATODE, Root Knot. **Meloidogyne** spp., TN, TX, WV; **M. javanica**.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, NY; **Erysiphe polygoni**, PA.
ROT, Root. **Rhizoctonia solani**, IN, NJ, NC, TX; **Pythium ultimum**, CA; **Phymatotrichum omnivorum**, TX.
ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, CA, FL, LA, MO, OH, TX.

RUST. **Puccinia flaveriae** (III), IL, IN, IA, KS, MO, NE, TX.
SMUT, White. **Entyloma calendulae**, CA, NH, OR; **E. compositarum**, WA.
VIRUS. **Cucumber Mosaic**,**Tomato Spotted Wilt**, CA, MI, TX; **Bidens Mottle**, FL.

CALIBRACHOA (*Calibrachoa* sp.)

VIRUS. **Calibrachoa Mottle**, CA.

CALIFORNIA-BLUEBELL (*Phacelia*)

LEAF SPOT. **Cylindrosporium phaceliae**, MT, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, MT, NM, TX.
RUST. **Puccinia aristidae** (0, I); II, III on wild grasses; **P. phaceliae** (III); **P. recondita** (0, I), MT to CO, CA, NM, OR; II, III on bromegrass; **Uredo contraria** (II), CA.
VIRUS. **Beet Curly Top**, CA.

CALIFORNIA-LAUREL (*Umbellularia*)

ANTHRACNOSE. **Kabatiella phorodendri** f. sp. **umbellulariae**, CA;
LEAF BLIGHT, **Colletotrichum gloeosporioides**.
BACTERIAL Leaf Spot. **Pseudomonas lauraceum**, CA.
BLACK MILDEW. **Asterina anomala**, CA.
CANKER; DIEBACK. **Nectria cinnabarina**; **N. coccinea**, CA.
LEAF SPOT, Sudden Oak Death. **Phytophthora ramorum**, CA.
NEMATODE, Pin. **Paratylenchus (Gracilacus) anceps**. Ring, **Criconemoides xenoplax**, CA; Sheath **Hemicycliophora brevis**, CA.
NEMATODE, Root Knot. **Meloidogyne hapla**, CA.
ROT, Wood. **Fomes** spp., **Lenzites betulina**; **Polyporus versicolor**; **Porio ambigua**; **P. ferruginosa**; **Stereum albobadium**; **Schizophyllum commune**.

CALIFORNIA PEPPER-TREE (*Schinus*)

DODDER. **Cuscuta subinclusa**, CA.
LEAF SPOT. **Rhizoctonia solani**, FL.

NEMATODE, Root Knot. **Meloidogyne** sp., TX.
ROT, Heart. **Fomes applanatus**, CA; **Polyporus dryophilus**, CA; **P. farlowii**, AZ, CA; **P. sulphureus**; **P. versicolor**, CA.
ROT, Root. **Armillaria mellea**, CA; **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Ganoderma polychromum**, CA; **Stereum hirsutum**; **Trametes hispida**, CA; **Schizophyllum commune**.
WILT. **Verticillium albo-atrum**, CA.

CALIFORNIA PITCHER-PLANT (*Darlingtonia*)

LEAF SPOT. **Mycosphaerella sarraceniae**, CA; **Septoria darlingtoniae**, OR.

CALIFORNIA POPPY (*Eschscholtzia*)

BACTERIAL Blight. **Xanthomonas papavericola**, TX.
BACTERIAL, MLO. **Aster Yellows**, NJ, NY; and **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT, Mold. **Heterosporium eschscholtziae**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., FL, TX.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Collar. **Alternaria** sp., TX.
SMUT, Leaf. **Entyloma eschscholtziae**, CA.
WILT. **Verticillium albo-atrum**, CA.

CALIFORNIA-ROSE (*Convolvulus japonicus*)

LEAF SPOT. **Phyllosticta batatas**, SC; **Septogloeum convolvuli**, CA, WI; **Septoria calystegiae**, CA; **S. convolvuli**, WI; **S. flagellaris**, NY.
RUST. **Coleosporium ipomoeae** (II, III), LA, MA, 0, I on pine; **Puccinia convolvuli** (0, I, II, III), CA, OR.

CALLA, COMMON, GOLDEN, PINK (*Zantedeschia*)

BACTERIAL Soft Rot. **Erwinia aroideae**, general; **E. carotovora**.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, NJ.

BLIGHT, Southern. **Sclerotium rolfsii**, CA, FL, OR.
LEAF SPOT. **Alternaria** sp., secondary; **Cercospora richardiaecola**, AL, MS; **Coniothecium richardiae**, CA, FL, MA, NJ, NY, OR; **Gloeosporium callae**, WA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA, FL.
NONPARASITIC. **Chalk rot**. Immaturity of rhizomes, CA, OR.
POWDERY MILDEW. **Leveillula taurica**, CA.
ROT, Rhizome. **Phytophthora cryptogea** var. **richardiae**, CA, FL, IL, MA, NJ, NY, OH, OR, PA, WA; **P. erythroseptica**, CA; **Phoma** sp., CA, OR.
ROT, Root. **Armillaria mellea**, CA; **Rhizoctonia solani**, CA.
VIRUS. **Dasheen Mosaic**; **Tomato Spotted Wilt**, CA, IL, IN, MD, NY, OR, TX, WA; **Calla Chlorotic Spot**, U.S.

Root and rhizome rots are controlled by treating rhizomes before planting and growing in pots rather than benches. Specimens showing spotted wilt must be destroyed before thrips spread the virus.

CALLA, WILD (*Calla palustris*)

LEAF SPOT. **Cercospora callae**, MA, NY, WI; **Marssonina callae**, NY.

CALLIANDRA (False-Mesquite)

ROT, Root. **Clitocybe tabescens**, FL.
RUST. **Ravenelia reticulatae** (II, III), AZ.

CALLICARPA (Beauty-Berry; French-Mulberry)

BLACK MILDEW. **Meliola cookeana**, FL, LA.
LEAF SPOT. **Cercospora callicarpae**, SC to TX.
NEMATODE, Burrowing. **Radopholus similis**, FL.

CALYCANTHUS (Sweetshrub, Carolina Allspice)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MS, NY.
CANKER. **Botryosphaeria calycanthi**, NC, VA.
POWDERY MILDEW. **Phyllactinia corylea**, CA.

CAMASS (*Camassia*)

BLIGHT, Gray Mold. **Botrytis cinerea**, OR.
LEAF SPOT. **Septoria chlorogali**, OR.
ROT, Root. **Phymatotrichum omnivorum**, TX.
SMUT, Leaf. **Urocystis colchici**, IN, OR.

CAMELLIA

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, WA.
BLACK MILDEW. **Meliola camelliae**.
BLIGHT. **Phytophthora ramorum**, CA, OR, WA.
BLIGHT, Flower. **Sclerotinia camelliae**, CA, GA, LA, MS, NC, SC, TX, VA; **S. sclerotiorum**, NC; **Pestalotia** sp., **Penicillium** sp., AL.
BLIGHT, Gray Mold; Bud and Flower. **Botrytis cinerea**, general after frost.
BLIGHT, Petal. **Pestalotia** sp., AL.
CANKER; DIEBACK. **Glomerella cingulata**, widespread; **Botryosphaeria ribis**, MS; **Phomopsis** sp., FL.
CANKER, Felt Fungus. **Septobasidium castaneum**; **S. conidiophorum**; **S. pseudopedicellatum**, SC.
DODDER. **Cuscuta** sp.
GALL, Leaf. **Exobasidium camelliae**, and var. **gracilis** on *Camellia sasanqua*, FL, LA, MS, TX; **E. monosporum**, AL.
LEAF SPOT. **Cercospora** sp., GA; **C. theae**, LA; **Hendersonia subalbicans**, GA; **Pestalotia quepini**, also twig blight, widespread; **Phyllosticta camelliae** and **P. camelliaecola**, Southeast; **Sporonema camelliae**.
LEAF SPOT, Algal. **Cephaleuros virescens**, Gulf states.
NEMATODE, Burrowing. **Radopholus similis**, FL.
NEMATODE, Lesion. **Pratylenchus coffeae**.
NEMATODE, Ring. **Criconemoides komabaensis**, FL; **Hemicriconemoides gaddi**, LA, GA.
NEMATODE, Root Knot. **Meloidogyne incognita**.
NEMATODE, Spiral. **Helicotylenchus nannus**.
NONPARASITIC. **Bud Drop, Dieback**. Malnutrition, freezing, desiccation, widespread.
Oedema. Corky excrescences, from disturbed water relations.
Sunscald. Light circular spots, often with secondary fungi.

ROT, Root. **Phytophthora cinnamomi**, major problem, AL, CA; **Clitocybe tabescens**, FL, LA.
SPOT ANTHRACNOSE, Scab. **Elsinoë leucospila**, FL, GA, LA.
VIRUS. **Camellia Yellow Mottle Leaf** (color-breaking strains).
Flower blight is a devastating disease that has spread with plants in cans or pots. Order camellias bare-rooted, with all flower buds showing color picked off. Dieback is the subject of much controversy among camellia fans. Drastic surgery and a copper spray early in the season to prevent infection through bud scars seems to be helpful. Chelated iron may mask color-breaking virus symptoms.

CAMOMILE (*Anthemis*)

BACTERIAL, MLO. **California Aster Yellows**, CA.
DAMPING-OFF. **Rhizoctonia solani**, WA.
NEMATODE, Root Knot. **Meloidogyne** sp., FL, MD.
ROT, Root. **Phymatotrichum omnivorum**, TX.

CAMPANULA (Bellflower, Canterbury Bells)

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.
BACTERIAL, MLO. **Aster Yellows**, PA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, IL, NJ.
LEAF SPOT. **Ascochyta bohemica**, WI; **Cercoseptoria minuta**, WI; **Phyllosticta alliariifoliae**, NJ, NY; **Ramularia macrospora**, AK; **Septoria campanulae**, IL, IA, KS, MO, WI.
NEMATODE, Leaf. **Aphelenchoides** sp.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Golovinomyces cichoracearum**, PA.
ROT, Root. **Fusarium** sp., NY, NJ; **Rhizoctonia solani**, CT, IL, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, MD, WA.
RUST. **Coleosporium campanulae** (II, III), widespread; 0, I on pine; **Aecidium campanulastri** (0, I), IA, MN; **Puccinia campanulae** (III), CA, MT, NY, OR, WA.
VIRUS. **Tomato Spotted Wilt**, CA.
WILT. **Verticillium albo-atrum**.

CAMPHOR-TREE (*Cinnamomum*)

ANTHRACNOSE. **Glomerella cingulata**, Gulf states.
BLACK MILDEW. **Lembosia camphorae**, FL.
CANKER; DIEBACK. **Diplodia camphorae**, **D. natalensis**, **D. tubericola**, widespread; **Gloeosporium camphorae** and **G. ochraceum**, also leaf spot, Gulf states.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL to LA.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL.
NEMATODE, Lesion. **Pratylenchus pratensis**, FL.
NONPARASITIC. **Chlorosis**. Manganese deficiency, FL.
POWDERY MILDEW. **Microsphaera alni** var. **cinnamomi**, LA.
ROT, Root. **Armillaria mellea**, FL; **Phymatotrichum omnivorum**, TX; **Clitocybe tabescens**, FL.
SPOT ANTHRACNOSE. **Elsinoë cinnamomi**, MS, SC.

CANDLESTICK SHRUB (*Cassia*)

LEAF SPOT. **Tubakia dryina**, LA.

CANDYTUFT (*Iberis*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
CLUB ROOT. **Plasmodiophora brassicae**, MS, NJ.
DODDER. **Cuscuta indecora**, TX.
DOWNY MILDEW. **Peronospora parasitica**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., AL.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Root. **Phoma lingam**, CA; **Pythium oligandrum**, ME.
VIRUS. **Lettuce Mosaic**, NY
WHITE RUST. **Albugo candida**, CA.

CANNA

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Alternaria** sp., MI, SC, TX.
NEMATODE, Burrowing. **Radopholus similis**.

ROT, Rhizome. **Fusarium** sp., MN, MO, PA.
RUST. **Puccinia cannae** (II, III), FL, OH, TX.
VIRUS. **Cucumber Mosaic**, OH, RI; **Mosaic**; unidentified, DE, MD, MI, NY; **Canna Yellow Mottle**.

CANOLA (*Brassica napus*)

BLACK LEG. **Septosphaeria maculans**, KY; **Leptosphaeria maculans**, Canada, ND.
DECLINE SYNDROME. Causal agent unknown, GA, KY, TN.
PHYTOPLASMA. **Candidatus asteris** (also on **Brassica rapa**), Saskatchewan, Canada.
ROT, Damping-off. **Rhizoctonia solani**, WA.
ROT, Stem. **Sclerotinia sclerotiorum**, GA.

CANTALOUPE

► Melon.

CAPE-COWSLIP (*Lachenalia*)

VIRUS. **Ornithogalum Mosaic**, AL.

CAPE-HONEYSUCKLE (*Tecomaria*)

ANTHRACNOSE. **Colletotrichum gloeosporioides**, TX.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL.

CAPE-MARIGOLD (*Dimorphotheca*)

BACTERIAL, MLO. **Aster Yellows**, NJ, NY.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, CT.
DOWNY MILDEW. **Plasmopara halstedii**, IA, ND.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Charcoal. **Macrophomina phaseoli**, CA.
ROT, Root. **Pythium ultimum**, CA; **Rhizoctonia solani**, IL.
RUST. **Puccinia flaveriae** (III), IL, IN, NE, NJ.

VIRUS. **Curly Top Virus** (**Beet**) on *Dimorphotheca pluvialis* var. *fingens* and D. *sinuata*.
WILT. **Fusarium** sp., FL.

CAPEWEED, CAPE DANDELION (*Arctotheca calendula*)

BLIGHT; ROT, Root, Crown and Stolon. **Sclerotium rolfsii**, CA.

CAPER (*Capparis*)

BLACK MILDEW. **Asterina lepidigenoides**, FL; **A. radians**, FL.

CARAWAY (*Carum*)

BACTERIAL, MLO. **California Aster Yellows**, WA.
DODDER. **Cuscuta** sp., WA.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Stem. **Sclerotinia sclerotiorum**, WA.

CARDOON (*Cynara cardunculus*)

LEAF SPOT. **Cercospora obscura**, CA, TX; **Ramularia cynarae**, CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA.

CARISSA

CANKER; DIEBACK. **Physalospora obtusa** and **P. rhodina**, FL.
LEAF SPOT. **Colletotrichum gloeosporioides**, FL; **Macrophoma** sp., CA; **Septoria** sp., CA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.

CARISSA (Natal-Plum)

CANKERS; GALL. **Sphaeropsis tumefaciens**, FL.

CARNATION (*Dianthus caryophyllus*)

ANTHRACNOSE. **Colletotrichum** sp., NJ, NY, TX.
BACTERIAL Blight. **Pseudomonas woodsii**, HI.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD.
BACTERIAL Fasciation; Witches' Broom. **Clavibacter fascians**, CA, OH.
BACTERIAL, MLO. **Aster Yellows**.
BACTERIAL Pimple. **Xanthomonas oryzae**.
BACTERIAL Spot. **Pseudomonas woodsii**, MS to GA, IN, MI, ND, OK, OR, WA.
BACTERIAL Wilt. **Pseudomonas caryophylli**, IL, IN, IA, MA, MO, WA.
BLIGHT, Branch and Collar Rot. **Alternaria dianthi**, general.
BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan in high humidity.
BLIGHT, Petal. **Stemphylium floridanum**, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, MS, TX.
BLIGHT, Web. **Pellicularia koleroga**, NC.
BLOTCH, Greasy. **Zygophiala jamaicensis**, CA, PA.
DOWNY MILDEW. **Peronospora dianthicola**, CA.
LEAF SPOT, Mold; Fairy Ring. **Heterosporium echinulatum** occasional in greenhouses, CA, TX; **Cladosporium herbarum**, secondary, general.
LEAF SPOT. **Cladosporium echinulatum**, HI; **Septoria dianthae**, VT to SC, CA, MI, TX.
NEMATODE, Cyst. **Heterodera trifolii**.
NEMATODE, Lance. **Hoplolaimus coronatus**.
NEMATODE, Pin. **Paratylenchus dianthus**.
NEMATODE, Ring. **Criconemoides curvatum**.
NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. hapla**; **M. incognita-acrita**; **M. javanica**.
NONPARASITIC. **Yellow Spotting**. Potassium deficiency, NJ, NY.
PETAL SPOT. **Bipolaris** (*Helminthosporium*) **setariae**, FL.
POWDERY MILDEW. **Oidium** sp., FL, NC; **O. dianthi**, CA.
ROT, Bud. **Fusarium tricinctum** f. sp. **poae**, MA to VA, KS, NE, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium** sp., IL; **Rhizoctonia solani**, general; **Armillaria mellea**, CA.
ROT, Stem. **Armillaria mellea**, CA; **Fusarium cerealis**, general.
RUST. **Uromyces dianthi** (II, III), general.
SMUT. Anther. **Ustilago violaceae**, MA.

VIRUS. **Carnation Latent**; **Carnation Mosaic**; **Carnation Mottle**; **Carnation Ring Spot**; **Carnation Streak**; **Carnation Yellows**; **Carnation Etch-Ring**; **Beet Curly Top**, CA, TX; **Carnation Necrotic Fleck**, CA; **Carnation Italian Ring Spot**; **Carnation Vein Mottle**.

WILT. **Fusarium oxysporum** f. sp. **dianthi**; **Verticillium albo-atrum** (*dahliae*), NJ; **Phialophora** (*Verticillium*) **cinerescens**, NY.

A rigid sanitation program is necessary for healthy carnations, taking cuttings high on the plant, breaking instead of cutting, planting in sterile medium, controlling aphids and other insect vectors of virus diseases and controlling mites that spread bud rot. The mother block system controls wilts; heat cures viruses.

CAROB, ST. JOHNS BREAD (*Ceratonia*)

CANKER. **Botryosphaeria ribis**, CA.

NEMATODE, Root Knot. **Meloidogyne** spp.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Phytophthora cactorum**, CA.

WILT. **Verticillium albo-atrum**, CA.

CAROLINA GERANIUM (*Geranium carolinianum*)

BLIGHT, Stem and Leaf. *Sclerotinia minor*, NC.

VIRUS. Tomato Spotted Wilt, GA.

CAROLINA JESSAMINE (*Gelsemium*)

BLACK MILDEW; Black Spot. **Asterina somatophora**, FL.

LEAF SPOT. **Phyllosticta gelsemii**, NJ.

ROT, Root. **Phymatotrichum omnivorum**, TX.

SOOTY MOLD. **Capnodium grandisporum**, MS, TX.

CAROLINA MOONSEED (*Cocculus*)

LEAF SPOT. **Cercospora cocculicola**, OK; **C. menispermi**, MS, TX.

NEMATODE, Burrowing. **Radopholus similis**, FL.

ROT, Root. **Phymatotrichum omnivorum**, TX.

CARPETWEED (*Mollugo*)

VIRUS. **Tomato Spotted Wilt**, GA.

CARROT (*Daucus carota* var. *sativa*)

BACTERIAL Blight. **Xanthomonas carotae**, CA, ID, IA, WI.

BACTERIAL Core-Rot. **Erwinia chrysanthemi** and/or **E. carotovora** var. **carotovora**, IL.

BACTERIAL, MLO. **Aster Yellows**, widespread and California strain, CA, ID, OR, WA.

BACTERIAL Soft Rot. **Erwinia carotovora**, general.

BLIGHT, Early; Leaf Spot. **Cercospora carotae**, general.

BLIGHT, Late. **Alternaria dauci**, general.

BLIGHT, Southern. **Sclerotium rolfsii**, GA to FL, CA, TX.

CANKER, Root; Storage Rot. **Rhizoctonia** spp., MI, NY, OR, WA.

DAMPING-OFF. **Pythium** sp., ID; **Rhizoctonia solani**, general.

DODDER. **Cuscuta** sp., ID, MS, NM, NY, TX, WV.

LEAF SPOT. **Ramularia** sp., KS; **Alternaria tenuis**, secondary, also seed mold; **Cercospora carotae**, WA.

NEMATODE. **Nacobbis batatiformis**.

NEMATODE, Cyst. **Heterodera carotae**.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. incognita**; **M. javanica**.

NONPARASITIC. **Black Heart**. Cause unknown, WI.

Chlorosis. Magnesium deficiency in acid soil.

Root Girdle. Cause unknown.

POWDERY MILDEW. **Erysiphe polygoni**, CA; **E. heraclei**, NY, NC, WA.

ROT, Black. **Alternaria radicina**, ID, MA, MI, NY, PA, WA.

ROT, Black Mold. **Rhizopus** spp.; Blue Mold, **Penicillium** sp.; Gray Mold, **Botrytis cinerea**; Pink Mold, **Trichothecium roseum**, IN.

ROT, Crown. **Rhizoctonia solani**, GA.

ROT, Dry. **Fusarium** spp., ID, NY, associated with scab; **Mycocentrospora acerina**, WA.

ROT, Root. **Helicobasidium purpureum**, OR, WA; **Phymatotrichum omnivorum**, AZ, LA, TX; **Phytophthora megasperma**, CA; **Sclerotinia minor**, **S. sclerotiorum**, Ontario, Canada.

ROT, Storage. **Centrospora acerina**, NY; **Aspergillus niger**; **Pellicularia filamentosa**; **Typhula** sp.
ROT, Watery Soft. **Sclerotinia sclerotiorum**, general; **S. intermedia**, **S. minor**.
RUST. **Uromyces scirpi** (0, I), OR; II, III on *Scirpus*.
SCAB. **Streptomyces scabies**, CA, MI, PA, WA.
SCAB, Acid. **Streptomyces acidiscabies**, ME.
SPIROPLASMA. **Carrot Purple Leaf**. **Spiroplasma citri**, WA.
VIRUS. **Alfalfa Mosaic**, CA, WA; **Clover Yellow Vein**, WA.
VIRUS. **Beet Curly Top**, OR, UT; **Carrot Motley Dwarf**; **Celery Mosaic**; **Carrot Red Leaf**; **Carrot Thin Leaf**, CA; **Lettuce Infectious Yellows**, AZ, CA.

Carrots in home gardens require a deeply dug friable soil even more than treatment for diseases. Root-knot nematodes are rather common.

CARROT, WILD (*Daucus carota*)

VIRUS. **Alfalfa Mosaic**, WA; **Clover Yellow Vein**, WA.

CASCARA (*Ramnus ramorum*)

LEAF SPOT, Black. **Phytophthora ramorum**, CA.

CASHEW (*Anacardium*)

BLIGHT, Seedling. **Sclerotium rolfsii**, FL.

CASSABANA, CURUBA (*Sicana*)

ANTHRACNOSE. **Colletotrichum lagenarium**, FL.

CASSIA (Senna, Sicklepod, Partridgepea)

BLIGHT, Seedling. **Alternaria cassiae**, MS.
CANKER, Stem. **Diaporthe phaseolorum** var. **caulivora**, LA.
DIEBACK. **Diplodia natalensis**, TX.

LEAF SPOT. **Cercospora nigricans**, MS; **Septoria cassiicola**; **Tubakia dryina**, LA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA, TX.
POWDERY MILDEW. **Microsphaera alni**, MD; **Erysiphe polygoni**.
ROT, Black. **Cylindrocladium parasiticum**, GA.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
WILT. **Fusarium oxysporum** f. sp. **cassiae**, FL, GA, NC, SC.

CASSIOPE

LEAF GALL. **Exobasidium vaccinii**, WA.

CASTOR-BEAN (*Ricinus communis*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**.
BACTERIAL Leaf Spot. **Xanthomonas ricinicola**, MD, OK, TX.
BACTERIAL Wilt. **Pseudomonas solanacearum**, AL, FL, GA, MI.
BLIGHT, Influorescence; Gray Mold. **Botryotinia ricini**, GA to FL, TX.
BLIGHT, Southern. **Sclerotium rolfsii**.
DAMPING-OFF. **Rhizoctonia solani**, FL, KS.
GALL. **Synchytrium** sp., TX.
LEAF SPOT. **Alternaria** sp., FL, LA, TX; **Cercospora canescens**, AL, KS, MT; White Spot, **C. ricinella**; **Corynespora cassiicola**.
NEMATODE, Root Knot. **Meloidogyne** sp., OK.
NEMATODE, Burrowing. **Radopholus similis**, FL.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, FL; **Phytophthora parasitica**, FL.

CASUARINA (Australian-Pine)

NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL.
Casuarina is particularly susceptible to Clitocybe root rot but *C. cunninghamiana* is more resistant than other species.

CATALINA CHERRY (*Prunus lyoni*)

LEAF SPOT; Shot Hole. **Coryneum beierincki**.

CATALPA

ANTHRACNOSE. **Gloeosporium catalpae**, MD, MA, NJ, NY, PA.
BLIGHT, Southern. **Sclerotium rolfsii**, on seedlings.
DAMPING-OFF. **Rhizoctonia solani**, NE; **Pythium ultimum** (somewhat resistant).
LEAF SPOT. **Alternaria catalpae**, widespread; **Cercospora catalpae**, MA to FL, TX and IA; **Phyllosticta catalpae**, general.
NEMATODE, Root Knot. **Meloidogyne** sp., southern states to OH.
NONPARASITIC. **Chlorosis**. Soil alkalinity.
Leaf Scorch. Heat, drought.
POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, MA to AL, IL, NE, TX; **Phyllactinia corylea**, IL, IN, KY, MA, OH, SC, VA.
ROT, Root. **Armillaria mellea**, WA; **Helicobasidium purpureum**, OH; **Phymatotrichum omnivorum**, TX; **Thielaviopsis basicola**, of seedlings.
ROT, Wood. **Collybia velutipes**, IN; **Polyporus** spp.; **Schizophyllum commune**; **Stereum** spp.; **Trametes sepium**.
SOOTY MOLD. **Capnodium axiliatum**, LA, SC.
SPOT ANTHRACNOSE. **Sphaceloma** sp.
WILT. **Verticillium albo-atrum**, IL, IN, KS, MA, NJ, NY, OH, VA.
Leaf spots may cause some defoliation in a wet season, but many years the expense of spraying may be unjustified on a limited budget. Verticillium wilt kills street trees.

CATHA (Arabian-Tea)

BLIGHT, Leaf Tip, **Colletotrichum gloeosporioides**, FL.

CATNIP (*Nepeta*)

BACTERIAL Leaf Spot. **Pseudomonas tabaci**, WI; **Xanthomonas campestris**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Ascochyta nepetae**, WI; **Cercospora nepetae**, IL, TX; **Phyllosticta decidua**, IL, NY, OH, WI; **Septoria alabamensis**, AL; **S. nepetae**, WI.

ROT, Root. **Rhizoctonia solani**, TX.
VIRUS. **Cucumber Mosaic**, IN, IA, KS, MI, WI.
WILT. **Fusarium** sp., GA.

CAT-TAIL (*Typha*)

LEAF SPOT. **Stagonospora typhoidearum**, TX, WI; **Phyllosticta typhina**, NE, NY, OR, TX, WI; **Scolecotrichum typhae**, CO.
MOLD, Leaf. **Cladosporium** spp., general.
ROT, Culm. **Ophiobolus** sp., AR.
ROT, Leaf. **Phythiogeton autossytum**, OH; **Pythium helicoides**, OH.

CATS-CLAW (*Doxantha*)

ROT, Root. **Phymatotrichum omnivorum**, TX.

CEANOTHUS

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, WA.
LEAF SPOT. **Cercospora ceanothi**, KS, WI; **Septoria ceanothi**, ID; **Cylindrosporium ceanothi**, Pacific Coast; **Phyllosticta ceanothi**, MS.
POWDERY MILDEW. **Microsphaera alni**, widespread.
ROT, Root. **Armillaria mellea**, CA.
ROT, Sapwood. **Schizophyllum commune**, CA.
RUST. **Puccinia tripsaci** (0, I), KS, NE, WI; II, III on grasses.
WILT. **Verticillium albo-atrum**, CA.

CEDAR (*Cedrus* spp.) (Atlas Cedar, Deodar, Cedar of Lebanon)

CANKER; DIEBACK. **Diplodia pinea**, AL; **Sirococcus conigenus**, OR.
ROT, Heart. **Fomes pini**, occasional.
ROT, Root, **Armillaria mellea**, MS; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum** TX; **Phytophthora cinnamomi**, CA.

CELANDINE (*Chelidonium*)

LEAF SPOT. **Septoria chelidonii**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

CELERY, CELERIAC (*Apium graveolens*)

BACTERIAL Leaf Spot. **Pseudomonas jaggeri** pv. **apii**, CT, DE, FL, IN, MI, MN, ND, NY, OH; Leaf Blight, **P. cichorii**, FL; **Pseudomonas syringae** pv. **apii**, CA.

BACTERIAL, MLO. **California Aster Yellows**, CA, ID, UT, WA.

BACTERIAL Soft Rot. **Erwinia carotovora**, cosmopolitan.

BLIGHT, Early. **Cercospora apii**, general.

BLIGHT, Late. **Septoria apiicola** (includes *S. apii* large leaf spot, and *S. apii-graveolentis*), general.

DAMPING-OFF. **Pythium mastophorum**, CA; **Pythium** spp.; **Rhizoctonia solani**; **Aphanomyces euteiches**, cosmopolitan.

LEAF SPOT. **Phyllosticta apii**, DE, NJ; **Stemphylium** sp. and **Alternaria** sp., secondary.

NEMATODE, Awl. **Dolichodorus heterocephalus**, red root, FL.

NEMATODE, Pin. **Paratylenchus hamatus**, New England, CA; **P. projectus**, NJ.

NEMATODE, Root Knot. **Meloidogyne incognita**.

NEMATODE, Sheath. **Hemicycliophora parvana**, FL.

NEMATODE, Stem. **Ditylenchus dipsaci**, CA.

NEMATODE, Sting. **Belonolaimus gracilis**, FL; **B. longicaudatus**.

NEMATODE, Stubby Root. **Paratrichodorus christiei**.

NONPARASITIC. **Black Heart**. Wide fluctuations of soil moisture, general.

Brown Stem. Over-age plants.

Cracked Stem. Boron deficiency.

Hollow Stem. Pithiness. Sometimes chilling; sometimes genetic.

POWDERY MILDEW. **Erysiphe heraclei**, CA.

ROT, Petiole and Crown. **Sclerotinia minor**, CA.

ROT, Gray Mold. **Botrytis cinerea**, cosmopolitan.

ROT, Pink; Watery Soft. **Sclerotinia sclerotiorum**, general; **S. intermedia**; **S. minor**.

ROT, Root; Scab on celeriac. **Phoma apiicola**, CA, MI, NY, OH, WI.

ROT, Stem; Brown Spot. **Cephalosporium apii**, CA.

ROT, Storage. **Centrospora acerina**, NY; **Typhula variabilis**, NY; **Tricothecium roseum**, pink mold, NY.

SLIME MOLD. **Physarum** spp., CA.

VIRUS. **Celery Calico**, CA, FL, NY, OH; **Celery Mosaic**, AL, CA, FL, WA; **Cucumber Mosaic**; **Beet Curly Top**, OR; **Celery Yellow Spot**,

CA; **Tomato Spotted Wilt**; **Lettuce Mosaic**, NY; **Broad Bean Wilt**, NY.

WILT, Yellows. **Fusarium oxysporum** f. sp. **apii**, CA, MI, NY, TX, general.

WILT. **Verticillium albo-atrum**, CA.

In many areas soil treatment for nematodes increases yield. Yellows-resistant varieties are on the market. Seed should be treated for leaf blights unless more than 2 years old. In Florida, development of apothecia of *Sclerotinia* is inhibited by flooding fields. Western growers fight mosaic by celery-free periods and by controlling insect vectors.

CELTUCE (*Lactuca serriota* var. *sativa*)

DOWNY MILDEW. **Bremia lactucae**, ND, PA, WA.

LEAF SPOT. **Septoria lactucae**.

ROT, Watery Soft; Drop. **Sclerotinia sclerotiorum**, MA.

Celtuce is a kind of lettuce and subject to some of the same diseases.

CENCHRUS (Buffelgrass)

BLIGHT. **Pyricularia grisea**, TX.

CENTAUREA (Bachelors-Button, Basketflower, Cornflower, Dusty-miller, Yellow Starthistle)

BACTERIAL, MLO. **Aster Yellows**, widespread; **California Aster Yellows**, CA.

BLIGHT, Southern. **Sclerotium rolfsii**, CT, MD, NJ, TX.

DIEBACK, Stem. **Pseudomonas syringae**, MT.

DODDER. **Cuscuta** sp.

DOWNY MILDEW. **Bremia lactucae**, CA; **Plasmopara halstedii**, IA, TX.

NEMATODE, Root Knot. **Meloidogyne** sp., CA, FL, OH.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, CT.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium** sp.; **Rhizoctonia solani**, IL, IN, NJ, NY, TX.

ROT, Stem. **Sclerotinia sclerotiorum**, CA, IN, MS, MO, TX; **Phytophthora cactorum**, NY.

RUST. **Puccinia cyani** (0, I, III), MA to NC, CA, IN, OR, WA; **P. irrequisita** (II, III), TX; 0,1, unknown; **P. jaceae** var. **diffusa**; **P. acroptili**, NM; **P. jaceae** var. **solstitiales**, CA.
VIRUS. **Tomato Spotted Wilt**, PA.
WHITE RUST. **Albugo tragopogonis**, TX.
WILT. **Verticillium albo-atrum**, NY.
WILT, Stem Rot. **Fusarium oxysporum** f. sp. **callistephi**, MI.

CENTIPEDE GRASS (*Eremochloa*)

ANTHRACNOSE. **Colletotrichum graminicola**, FL.
LEAF MOLD. **Curvularia** sp., LA; **Stachybotrys** sp., MD.
ROT, ROOT. **Gaeumannomyces graminis**, GA.

CENTURY PLANT (*Agave*)

ANTHRACNOSE. **Glomerella cingulata** (*Colletotrichum agaves*) occasional.
BLIGHT, Gray Mold. **Botrytis cinerea**, after chilling.
LEAF SCORCH; Blight. **Stagonospora gigantea**, NM, TX.
LEAF SPOT. **Coniothyrium concentricum**, **C. agaves**, common.
LEAF SPOT, Black Patch. **Dothidella parryi**, CA.
LEAF SPOT, Black Rot. **Thielaviopsis paradoxa**, Mexico.
LEAF SPOT, Red Leaf Ring, **Pantoea ananatis**, Mexico.

CEPHALOTAXUS (Japanese Plum-Yew)

BLIGHT, Nursery. **Phomopsis juniperovora**, NY.

CESTRUM

BACTERIAL Canker, Vascular. **Clavibacter michiganense**, WY.

CHAEROPHYLLUM

BROOMRAPE. **Orobanche ramosa**, TX.

CHAMAECYPARIS (Atlantic White-Cedar, Port Orford White-Cedar, Alaska Yellow-Cedar, Hinoki Cypress, Sawara Cypress-Retinospora)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA.

BLIGHT, Nursery. **Phomopsis juniperovora**, widespread.

BLIGHT, Tip. **Pestalotia funerea**, MI, NJ, TX; **Didymascella chamaecyparissi**, NY.

CANKER, Bark Patch. **Aleurodiscus nivosus**, NJ.

NEMATODE. **Sphaeronema** sp., AK; **Crossonema** sp., AK.

NONPARASITIC. **Scorch**. Sun, freezing, drought, mites.

ROT, Collar and Root. **Phytophthora lateralis**, CA, OR, WA, serious; **P. cinnamomi**.

ROT, Heart. **Fomes pini**, occasional; **F. pinicola**, AK; **F. subroseus**, NJ, NC.

ROT, Root. **Armillaria mellea**, VA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX; **Pythium ultimum**, CA; **Phytophthora lateralis**, CA.

ROT, Wood. **Lenzites saepiaria**, VA; **Poria** spp.; **Polyporus** spp.; **Stecchérinum balloui**, NJ; **Trametes isabellina**, CA; **Fomes annosus**.

RUST, Gall. **Gymnosporangium biseptatum** (III), ME, NH to NJ, AL; 0, I on service-berry; **G. nootkatense** (III), AK, OR, WA; 0, I on crabapple, pear, mountain-ash; **G. fraternum** (III), ME, MA, NJ; 0, I on chokeberry.

RUST, Witches' Broom. **Gymnosporangium ellisii** (III), ME to FL and AL; 0, I on sweet fern, bayberry, wax-myrtle.

CHAMAEDAPHNE (Cassandra, Leatherleaf)

GALL, Leaf. **Exobasidium vaccinii**, widespread; **Synchytrium vaccinii**, NJ.

LEAF SPOT. **Ascochyta cassandrae**, NY to WI; **Venturia arctostaphyli**, NH, NY.

RUST. **Chrysomyxa ledi** var. **cassandrae** (II, III), ME to PA and MN; AK; 0, I on pine.

CHAYOTE (*Sechium*)

ANTHRACNOSE. **Colletotrichum lagenarium**, FL, TX.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Cercospora sechii**, FL, TX.
NEMATODE, Root Knot. **Meloidogyne** sp.; **M. incognita**.
NEMATODE, Stubby Root, **Trichodorus** sp.
ROT, Fruit. **Glomerella cingulata**, LA.

CHECKER MALLOW (*Sidalcea*)

LEAF SPOT. **Ramularia sidalceae**, CA, CO, WY.
RUST. **Endophyllum tuberculatum** (III), CO, WY; **Puccinia interveniens** (0, I), CA, CO, ID, MT, OR, WA, WY; II, III on *Stipa*; **P. schedonnardi** (0, I), CO; **P. sherardiana** (0, III), AZ, CA, CO, NV, OR, WA.

CHENOPODIUM

DAMPING-OFF. **Sclerotium rolfsii**, CA.
VIRUS. **Sowbane Mosaic**, CA. Commonly used as test plant (bioassay) for viruses.

CHERIMOYA, CUSTARD-APPLE (Annona)

ANTHRACNOSE, Fruit Rot. **Glomerella cingulata**, FL.
BLIGHT, Stem. **Diplodia natalensis**, TX.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Phakopsora cherimoliae** (II, III), FL, TX.

CHERRY (*Prunus* spp.)

BACTERIAL Black Spot; Canker; Gummosis. **Xanthomonas pruni**, NY to MI, GA and TX.
BACTERIAL Canker. **Pseudomonas syringae**, MA to MI; Pacific states and **P. morsprunorum**.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA, TX, WA.

BACTERIAL Fire Blight. **Erwinia amylovora**, OR, WA.

BACTERIAL, MLO. **Peach X-Disease**; **Peach Yellow Leaf Roll** (**Peach Western X-Disease**), Northwest.

BLACK KNOT. **Dibotryon morbosum**, eastern states.

BLIGHT, Shoot; Shot Hole. **Coryneum carpophilum** (*C. beijerinckii*), CA, ID, OR, WA.

BLIGHT, Blossom, Brown Rot. **Monilinia laxa**, general, Pacific states, MI, NY, WI.

BLIGHT, Seedling, Twig. **Monilinia rhododendri**, VT to GA, AR, IA; **M. fructicola**, shoot and leaf, GA.

CANKER, Felt Fungus. **Septobasidium retiforme**, GA.

CANKER, Trunk and Collar. **Phytophthora cactorum**, **P. citrophthora**, CA.

CANKER, Twig. **Phomopsis padina**; **Cytospora leucostoma**, NY, PA; **Valsa leucostoma**, widespread; **Nectria** sp., NY; **Eutypa lata** (syn. **E. armeniacae**), CA.

LEAF BLISTER. **Taphrina farlowii**, VT to FL, TX; **Taphrina cerasi**, ME to NJ, MN.

LEAF SPOT. **Cercospora circumscissa** (*Mycosphaerella cerasella*), NJ, PA, VA to FL, TX; **Alternaria citri** var. **cerasi**, CA; **Phyllosticta pruni-avium**, OR; **Cercospora graphioides** and **Phyllosticta serotina** on wild black cherry only; **Coccomyces lutescens**, VA.

LEAF SPOT; Blight; Shot hole. **Coccomyces hiemalis**, general.

MISTLETOE. **Phoradendron serotinum** (**flavescens**).

NEMATODE, Lesion. **Pratylenchus** sp.; **P. vulnus**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp; **M. incognita**; **M. javanica**.

NONPARASITIC. **Brown Bark Spot**. Arsenical poisoning of soil, ID, MT, WA.

Chlorosis. Alkali injury, CA, TX.

Little Leaf. Zinc deficiency, CA, OR, WA.

POWDERY MILDEW. **Podosphaera oxyacanthae**, general.

ROT, Brown. **Monilinia fructicola**, general.

ROT, Fruit. **Alternaria** sp.; **Botrytis cinerea**; **Cladosporium herbarum**, CA to WA and ID; **Lambertella** sp., OR; **Microstroma tonellianum**, MA; **Penicillium expansum**; **Rhizopus stolonifer**, occasional in market; **Pullularia** sp., Northwest; **Mucor piriformis**.

ROT, Heart; Wood. **Fomes fomentarius**, Northeast; **Polyporus** spp.; **Poria ambigua**, CA.

ROT, Root. **Armillaria mellea**, NM, OK, OR; **Phymatotrichum omnivorum**, TX; **Xylaria** spp., VA; **Poria ambigua**, CA.

ROT, Silver Leaf. **Stereum purpureum**, NY, MT.

RUST. **Tranzschelia discolor** (II, III), GA, MA, NE, NY, NC, OK, TX; 0, I on anemone.

SCAB. **Fusicladium cerasi**, NY to IA and WI.

VIRUS. **Cherry Rough Fruit**, UT on Sweet cherry (*Prunus avium*).

VIRUS. **Cherry Albino**; **Cherry Bark-Splitting**; **Cherry Black Canker**; **Cherry Buckskin**; **Cherry Bud Abortion**; **Cherry Chlorosis**; **Cherry Freckle Fruit Disease**; **Cherry Green Ring Mottle**; **Cherry Gummosis**; **Cherry Little Cherry**; **Cherry Midleaf Necrosis**; **Cherry Mora**; **Cherry Mottle Leaf**; **Cherry Necrotic Rusty Mottle**; **Cherry Pink Fruit**; **Cherry Pinto Leaf**; **Cherry Rasp Leaf**; **Cherry Ring Spot**; **Cherry Rugose Mosaic**; **Cherry Rusty Mottle**; **Cherry Twisted Leaf**; **Cherry Vein Clearing**; **Cherry Yellows**; **Prune Dwarf**; **Tomato Ring Spot**; **Stem Pitting**; **Prunus Necrotic Ring Spot**, CA, WA; **Plum Pox**, WA.

CHERRY, FLOWERING, ORIENTAL (*Prunus serrulata*)

BACTERIAL Fire Blight. **Erwinia amylovora**, GA, OH.

BACTERIAL Leaf Spot. **Xanthomonas pruni**, NJ.

CANKER; DIEBACK. **Botryosphaeria ribis**, GA.

DECLINE. Cause, unknown; complex of insect, poor soil, viral infection and air pollutants suspected, VA.

LEAF BLISTER; Witches' Broom. **Taphrina cerasi**, MD, NJ.

LEAF SPOT. **Coccomyces hiemalis**, MA, NJ.

SCAB. **Cladosporium carpophilum**, MS.

VIRUS. **Cherry Vein Clearing**; **Cherry (Flowering) Rough Bark**; **Cherry Little Cherry**.

CHERRY, JAPANESE FLOWERING (*Prunus subhirtella*)

LEAF SPOT. **Cristulariella pyramidalis**, FL.

CHERRY-LAUREL (*Prunus laurocerasus*)

BACTERIAL Spot. **Xanthomonas pruni**, GA, MS, NJ, SC.

BLIGHT, Blossom; Brown Rot. **Monilinia fructicola**, CA; **M. laxa**, CA; **Alternaria** sp., TX.

LEAF SPOT. **Cercospora circumscissa**, CA; **C. cladosporioides**, LA, TX; **Coccomyces lutescens**, MS; **Phyllachora beaumontii**, AL; **Phyllosticta laurocerasi**, CA, FL, NJ; **Septoria ravenelii**, SC.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL.

ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

WILT. **Verticillium albo-atrum**, CA.

CHESTNUT (*Castanea*)

BLIGHT, Canker. **Endothia parasitica**, general, with American chestnut practically exterminated by it.

BLIGHT, Twig. **Cytospora** sp.; **Phomopsis** sp.; **Diplodia longispora**.

CANKER, Bark Patch. **Aleurodiscus aceris**.

CANKER; DIEBACK. **Cryptodiaporthe castanea**; **Strumella coryneoidea**.

LEAF SPOT. **Actinopelte dryina**; **Cylindrosporium castaneae**; **Marssonina ochroleuca**, general; **Monochaetia desmazierii**; **M. kansensis**; **Phyllosticta castanea**; **Exosporium fawcettii**; **Scolecosporium fagi**.

MISTLETOE. **Phoradendron villosum**, CA.

POWDERY MILDEW. **Microsphaera alni**; **Phyllactinia corylea**.

ROT, Root. **Armillaria mellea**; **Phytophthora cinnamomi**; **Phymatotrichum omnivorum**.

ROT, Wood. **Fomes** spp.; **Polyporus** spp.; **Poria** spp.; **Stereum** spp.

Japanese and Chinese chestnuts are resistant to chestnut blight. Plant breeders are trying to develop hybrids between Asiatic and native species that will be resistant to *Endothia*.

CHICKORY

► Endive.

CHICK-PEA, GARBANZO (*Cicer*)

BACTERIAL, Blight. **Pseudomonas andropogonis**, ME.
BACTERIAL, Pink Seed. **Erwinia rhapontici**, Saskatchewan, Canada.
BLIGHT. **Ascochyta radiei**, ID, NE, WA.
NEMATODE, Root Knot. **Meloidogyne** spp.
ROT, Root. **Fusarium solani** f. sp. **pisi**; **Thielaviopsis basicola**, ID, WA.
ROT, Root; Damping-Off. **Pythium ultimum**, CA; **Rhizoctonia solani**, CA.
ROT, Stem. **Sclerotinia sclerotiorum**, ND, WA; **S. minor**, AR.
RUST. **Uromyces ciceris-arietini**, GA.
VIRUS. **Mosaic**, unidentified, CA; **Chickpea filiform**, WA; **Lettuce Mosaic**, CA; **Red Clover Vein Mosaic**, WA; **Pea Enation Mosaic**, ID, WA; **Bean leaf Roll**, ID, WA; **Pea Streak**, ID, WA.
WILT. **Fusarium lateritium** f. sp. **cicerii**; Vascular Disease; **Phialophora gregata**; **Fusarium solani** f. sp. **pisi**, CA. **Verticillium albo-atrum**.

CHICKWEED (*Stellaria* and *Cerastium*)

ROT. **Sclerotinia minor**, NC; **Sclerotium rolfsii** (stem), NC.
VIRUS. **Tomato Ringspot**, PA; **Tomato Spotted Wilt**, GA.

CHINABERRY (*Melia*)

BLACK MILDEW. **Meliola** sp.
BLACKLEG. **Phoma lingam**, WA.
BLIGHT, Limb; Twig. **Pellicularia koleroga**, FL; **Eutypella stellulata**, OK, TX; **Fusarium lateritium**, TX.
CANKER. **Nectria coccinea**, MS, SC.
DOWNY MILDEW. **Peronospora parasitica**, general.
LEAF SPOT. **Cercospora leucosticta**, Gulf states; **C. meliae**; **C. subsessilis**; **Phyllosticta azedarachis**, AL; **P. meliae**, LA, TX.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Phyllactinia corylea**, MS.
ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, AZ, TX.
ROT, Wood. **Fomes meliae**, AL; **Polyporus versicolor**, GA.

CHINESE CABBAGE (*Brassica pekinensis, B. chinensis*)

ANTHRACNOSE. **Colletotrichum higginsianum**, FL.
BACTERIAL Black Rot. **Xanthomonas campestris**, IN, MD, TX.
BACTERIAL Leaf Spot. **Pseudomonas maculicola**, VA.
BACTERIAL, MLO. **Aster Yellows**.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
CLUB ROOT. **Plasmodiophora brassicae**, CT, MA, NJ, OH, PA.
LEAF SPOT, Black. **Alternaria oleracea**, CA, CT, FL, MA, NH, TX; Gray, **A. brassicae**, CA, CT, FL, IN, MD; **Cercospora brassicola**, FL, GA, NH, NJ; **Cercosporella brassicae**, white spot, widespread.
LEAF SPOT; White Spot. **Pseudocercosporella capsellae**, CA.
NEMATODE, Root Knot. **Meliodogyne** sp.
POWDERY MILDEW. **Erysiphe polygoni**, AZ, MA; **Peronospora parasitica**.
ROT, Root; Damping-off. **Aphanomyces raphani**, WI.
ROT, Watery Soft. **Sclerotinia sclerotiorum**, AZ, MA, NY, TX.
VIRUS. **Turnip Mosaic**; **Cauliflower Mosaic**.
WHITE RUST. **Albugo candida**, AL.

CHINESE EVERGREEN (*Aglaonema*)

ANTHRACNOSE. **Colletotrichum** sp., **Gloeosporium** sp., WA.
BACTERIAL Leaf Spot. **Erwinia aroideae**; **Xanthomonas dieffenbachiae**, FL.
GLEBAL MASSES. **Sphaerobolus stellatus** (**Gasteromycetous fungus**), FL, TX.
LEAF SPOT. **Myrothecium roridum**, FL.
NEMATODE, Lesion. **Pratylenchus coffeae**, FL.
NEMATODE, Root Knot. **Meloidogyne javanica**.
ROT, Collar; Foliar Blight. **Fusarium subglutinans**, HI.
ROT, Root; Leaf. **Pythium splendens**, FL.
The root rot is serious, with all roots rotted, plants stunted, dying. Destroy infected plants. Take tip cuttings well above ground.

CHINESE LANTERN (*Physalis alkekengi*)

LEAF SPOT. **Alternaria solani**; **Phyllosticta** sp., OK; **P. physaleos**, CT.
SMUT, White. **Entyloma australe**, CT, NY.

VIRUS. **Cucumber Mosaic**; **Tobacco Mosaic**; **Potato Mottle**.
WILT. **Verticillium albo-atrum**, NY.

CHINESE TALLOWTREE (*Sapium*)

LEAF SPOT. **Cercospora stillingiae**, LA; **Phyllosticta stillingiae**, LA.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

CHINESE WAXGOURD (*Beincasa*)

ANTHRACNOSE. **Colletotrichum lagenarium**, IN.
DOWNY MILDEW. **Pseudoperonospora cubensis**, MA, OH.
NEMATODE, Root Knot. **Meloidogyne** sp.

CHINQUAPIN (*Castanopsis*)

BLIGHT, Chestnut; Canker. **Endothia parasitica**, general.
CANKER, Brown Felt. **Septobasidium pseudopedicellatum**.
LEAF BLISTER. **Taphrina castanopsidis**, CA.
LEAF SPOT. **Dothidella castanopsidis**, CA, OR; **Mycosphaerella** sp., CA, OR.
POWDERY MILDEW. **Microsphaera alni**, NC.
ROT, Heart; Sapwood; Wood. **Fomes igniarius**, OR; **Ganoderma oregonenses**; **Peniophora sanguinea**; **Polyporus hirsutus**; **P. versicolor**.
ROT, Root. **Armillaria mellea**, OR.
WILT, Oak. **Ceratocystis fagacearum**.

CHIOGENES (Creeping Snowberry)

RUST. **Chrysomyxa chiogenis** (II, III), MI, NH, NY, WI; 0, I unknown.

CHIONODOXA (Glory-of-the-Snow)

NEMATODE, Bulb. **Ditylenchus dipsaci**.

CHIRITA

VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

CHIVES (*Allium schoenoprasum*)

DOWNY MILDEW. **Peronospora destructor**, CA.
RUST. **Puccinia porri** (II, III), CT, NY, WA.
SMUT. **Urocystis cepulae**, MA.

CHLOROGALUM (Soap-Plant)

LEAF SPOT. **Heterosporium gracile**, CA.
RUST. **Uromyces aureus** (0, I, III), CA.

CHOKEBERRY (*Aronia*)

BACTERIAL Fire Blight. **Erwinia amylovora**, MI, TX, WV.
DODDER. **Cuscuta compacta**, FL.
LEAF SPOT. **Ascochyta pirina**, WI; **Cercospora mali**, AL, TX; **C. piri**, MI, NH, WI; **Mycosphaerella arbutifolia**, NY; **Phyllosticta arbutifolia**, NJ.
ROT, Brown. **Monilinia fructicola**, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Gymnosporangium clavariiforme** (0, I), MA; III on juniper; **G. clavipes** (0, I), CT, ME, MA, TX; **G. davisii** (0, I), ME, MI, NH, WI; **G. fraternum** (0, I), DE, MA, ME, NJ, PA; III on chamaecyparis.

CHOKECHERRY (*Prunus virginiana*)

BACTERIAL Leaf Spot. **Xanthomonas pruni**, IL, MT, NY, WY.
BACTERIAL, MLO. **Peach X-Disease**, NH to VA, IL, WI.
BLACK KNOT. **Dibotryon morbosum**, general.
BLIGHT, Fruit and Shoot. **Monilinia demissa**, ID, WA; **M. padi** (*Sclerotinia angustior*), VT to KS, ND.
CANKER; DIEBACK. **Cytospora chrysosperma**, MT.

CANKER, TWIG. **Eutypa lata** (syn. **E. armeniacae**), CA.
LEAF BLISTER; Fruit, Shoot Hypertrophy. **Taphrina confusa**, widespread.
LEAF SPOT. **Cylindrosporium nuttallii**, OR; **Gloeosporium prunicola**, NY; **Lophodermina prunicola**, tar spot, CO; **Mycosphaerella cerasella**, KS; **Phyllosticta circumscissa**; **P. virginiana**, leaf blotch, NY to KS and MT; **Septoria pruni**, MI.
LEAF SPOT; Shot Hole. **Cercospora circumscissa**, New England, IA, WI; ND to KS, and MT; **Cercospora lutescens**, general.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Podosphaera oxyacanthae**, widespread; **Phyllactinia corylea**, WA.
ROT, Brown Heart. **Fomes fulvus**, ND, SD.
RUST. **Tranzschelia pruni-spinosae** (II, III), CT to IL, WI.
VIRUS. **Western X-Disease**, ID, OR, UT, WA; **Tatter Leaf** (**Peach Ring Spot**).
Chokecherries should be eliminated near peach orchards to control the peach X-disease.

CHRISTMAS BERRY (*Heteromeles arbutifolia*)

BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, CA.
RUST. **Gymnosporium exiguum**, CA.

CHRISTMAS CACTUS (*Zygocactus truncatus*)

ROT, Basal Stem. **Fusarium oxysporum**, MA.
ROT, Root. **Phytophthora parasitica**, FL.
VIRUS. **Zygocactus Montana X**, MT.

CHRISTMAS ROSE (*Helleborus niger*)

BLIGHT, Flower Spot. **Botrytis cinerea**, NJ; **Gloeosporium** sp., NJ.
LEAF SPOT, Black. **Coniothyrium hellebori**, MD, NY, OR.
ROT, Stem. **Sclerotium delphinii** (*S. rolfsii*), NY.

CHRYSANTHEMUM (*Dendranthema grandiflora*)

BACTERIAL, MLO. **Phloem Necrosis**. MLO, widespread; **Aster Yellows**.

BACTERIAL Blight; Wilt. **Erwinia chrysanthemi**, serious in greenhouses; **E. carotovora**, OK; **Pseudomonas cichorii**, FL.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, FL, NJ, TX.

BACTERIAL Fasciation. **Clavibacter fascians**, MI, NJ, NY, OH.

BLIGHT, Blossom. **Phytophthora nicotianae**, AL.

BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan.

BLIGHT, Leaf; Blotch. **Septoria leucanthemi**, widespread.

BLIGHT, Petal. **Itersonilia perplexans**, FL, MN.

BLIGHT, Ray. **Ascochyta chrysanthemi** (*Mycosphaerella ligulicola*), MD to FL, CA, MS, OH; Ray Speck, **Stemphylium floridanum**, FL; **Alternaria** spp.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, VA.

DODDER. **Cuscuta** sp., MI, NJ, NY, WA, WV; **C. arvensis** and **C. indecora**, TX.

LEAF SPOT. **Alternaria** sp., OK, TX; **Cercospora chrysanthemi**, AL, LA, MD, PA, TX; **Cylindrosporium chrysanthemi**, MA to AL and KS; **Phyllosticta chrysanthemi**, FL, MA, MS, VA.

LEAF SPOT. **Septoria chrysanthemella** (*S. chrysanthemi*) and **S. obesa**, general.

NEMATODE, Leaf. **Aphelenchoides ritzemabosi**, widespread.

NEMATODE, Lesion. **Pratylenchus pratensis**, NJ, TX.

NEMATODE, Root Knot. **Meloidogyne** spp.

NONPARASITIC. **Crackneck**. In greenhouses, probably overwatering and insufficient ventilation **Air Pollution Injury**.

Yellow Strapleaf. Amino acid imbalance.

PETAL SPOT. **Bipolaris** (*Helminthosporium*) **setariae**, FL.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general.

ROT, Charcoal Stem. **Macrophomina phaseoli**, OK.

ROT, Flower. **Fusarium tricinctum** f. sp.**poae**, LA, NJ.

ROT, Root. **Fusarium** sp.; **Rhizoctonia solani**, general; **Pythium** sp.

ROT, Root. **Phymatotrichum omnivorum**, AZ, TX.

ROT, Stem. **Fusarium solani**.

ROT, Stem; Drop. **Sclerotinia sclerotiorum**, AZ, LA, MI, VA.

RUST. **Puccinia taneceti** (II), general.

RUST, WHITE. **Puccinia horiana** (III, IV), CA, FL, NJ, OR, PA.

VIROID. **Chrysanthemum Stunt**, serious; **Chrysanthemum Chlororic Mottle**, FL, NY, widespread.

VIRUS. **Chrysanthemum Flower Distortion**; **Chrysanthemum Mosaic**; **Chrysanthemum Ring Spot**; **Chrysanthemum Rosette**; **Impatiens Necrotic Spot**, GA, NC; **Tomato Aspermy**; **Tomato Spotted Wilt**.

WILT. **Fusarium oxysporum** f. sp. **callistephi**; **F. oxysporum** f. sp. **tracheiphilum**, SC.

WILT. **Fusarium oxysporum** f. sp. **chrysanthemi**, FL, SC, widespread.

WILT. **Verticillium albo-atrum**.

When garden chrysanthemums have foliage browning and dying progressively up the stem, the cause can be leaf nematodes, Septoria leaf spots, or Verticillium wilt. To reduce spread of nematodes home gardeners should take tip cuttings rather than crown divisions. Commercial growers should procure stock free from stunt and other virus diseases.

CHRYSOPSIS (Golden Aster)

LEAF SPOT. **Cercospora macroguttata**, AL, MS; **Ramularia chrysopsidis**, NY.

POWDERY MILDEW. **Golovinomyces cichoracearum**, MT, WY.

RUST. **Coleosporium asterum** (II, III), CO, FL, NE; 0, I on pine; **Puccinia grindeliae** (III), CA, CO, OK, UT, WY; **P. stipae** (0, I), AZ, CO, FL, MT, NE, WY; II, III on grasses.

CIMICIFUGA (Bugbane, Black Cohosh)

LEAF SPOT. **Ascochyta actaeae**, CT, NY; **Ectostroma afflatum**, VA.

NEMATODE, Root Knot. **Meloidogyne** spp., NJ.

CINCHONA

LEAF SPOT. **Cercospora cinchonae**, LA.

NEMATODE, Root Knot. Meloidogyne sp.

CINERARIA (*Senecio*)

BACTERIAL, MLO. **Aster Yellows**, NY.

BLIGHT. **Botrytis cinerea**, AK, IN, MO, NJ, PA.

DAMPING-OFF. **Rhizoctonia solani**, IL, NY.
DOWNY MILDEW. **Plasmopara halstedii**, NY.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Golovinomyces cichoracearum**, MA.
ROT, Root. **Pythium** sp., MD; **P. ultimum**; **Thielaviopsis basicola**, MA.
ROT, Stem. **Fusarium** sp., PA; **Phytophthora** sp., NJ; **Sclerotinia sclerotiorum**, WA.
RUST. **Puccinia lagenophorae**, NY.
VIRUS. **Cineraria Mosaic**, WA; **Tomato Spotted Wilt**; **Chrysanthemum Stunt** (viroid); **Impatiens Necrotic Spot**, NC.
WILT. **Verticillium albo-atrum**, NJ, NY, WA; **V. dahliae**, CA.

CINNAMON-TREE (*Cinnamomum zeylandicum*)

ANTHRACNOSE. **Glomerella cingulata**, FL.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL.

CIRSIUM (Plumed Thistle)

LEAF SPOT. **Alternaria chrysanthemi**, MT; **Cercospora** spp.; **Phyllosticta cirsii**; **Septoria cirsii**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Sphaerotheca macularis**.
ROT, Root. **Rhizoctonia solani**, IL; **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia cirsii** (0, I, II, III), PA to NC, CA, TX, OR; **Uromyces junci** (0, I), MT, NE, ND.
WHITE RUST. **Albugo tragopogonis**, NY to IA, TX, WY.
SMUT, Inflorescence. CO, UT.

CISSUS

LEAF SPOT. **Cercospora viticola**, LA; **C. arboreae**, TX; **Phyllosticta cissicola**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Aecidium mexicanum** (0, I), OK.
SMUT. **Mycosyrinx cissi**, FL.

CITRUS FRUITS (Grapefruit, Lemon, Lime, Orange)

ANTHRACNOSE; Withertip, Fruit Spot. **Glomerella cingulata**, general.

ANTHRACNOSE, Lime; Withertip. **Gloeosporium limetticolum**, on lime only, CA.

BACTERIAL Blast; Blight; Black Pit. **Pseudomonas syringae**, CA; after cold rains.

BACTERIAL Canker. **Xanthomonas campestris** pv. **citri**, FL.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, AZ, CA.

BACTERIAL, MLO. **Citrus Stubborn Disease**.

BLIGHT, Brown Spot; Fruit and Young Shoots. **Alternaria citri**, FL.

BLIGHT, Leaf and Stem. **Phytophthora syringae**, CA.

BLIGHT, Seedling; Fruit Rot. **Sclerotium rolfsii**.

BLIGHT, Thread. **Pellicularia koleroga**, Gulf states.

BLIGHT, Twig. **Gibberella baccata** (*Fusarium lateritium*), CA; **Tryblidiella rufula**, TX.

BLOTCH, Sooty. **Gloeodes pomigena**, Gulf states.

CANKER, Branch Knot. **Sphaeropsis tumefaciens**, FL.

CANKER, Branch Wilt. **Exosporina fawcettii**, CA.

CANKER; DIEBACK. **Aspergillus foetidus**, CA.

CANKER, Felt Fungus. **Septobasidium** spp., Gulf states.

CANKER, Trunk. **Botryodiplodia theobromea**, TX.

CANKER, Wound. **Hendersonula toruloidea**, CA.

DAMPING-OFF. **Pythium** spp.; **Rhizoctonia solani**, cosmopolitan.

DODDER. **Cuscuta americana**, CA, FL; **Cassytha filiformis**, a dodderlike plant, FL.

LEAF SPOT. **Cercospora aurantia**, FL, TX; Greasy Spot, **C. citri-grisea**, FL; Tar Spot, **C. gigantea**, FL; **Cladosporium oxysporum**, FL; **Mycosphaerella lageniformis**, CA; **Pleospora** sp., CA; **Alternaria citri**, on Rangpur lime; Fruit Spot, **Septoria citri**, CA, TX; **S. limonium**, CA.

LEAF SPOT, Algal; Red Rust. **Cephaleuros virescens**, Gulf states.

LEAF SPOT; Greasy Spot. **Mycosphaerella citri**, FL.

MISTLETOE. **Phoradendron** sp., Gulf states.

NEMATODE, Burrowing. **Radopholus similis**, FL.

NEMATODE, Citrus. **Tylenchus semipenetrans**, CA, FL.

NEMATODE, Lance. **Hoplolaimus coronatus**.

NEMATODE, Lesion. **Pratylenchus brachyurus**; **P. vulnus**.

NEMATODE, Ring. **Criconema civellae**; **Criconemoides citri**, FL.

NEMATODE, Stubby Root. **Paratrichodorus christiei**.

NONPARASITIC. **Blight**. Boron deficiency, CA, FL.

Blight. Boron deficiency, CA, FL.

Bronzing. Magnesium deficiency, FL.

Cancroid Spot. Genetic abnormality.

Chlorosis. Iron deficiency, AZ, CA, FL; manganese deficiency, FL.

Exanthema. Copper deficiency, augmented by excessive nitrogen fertilization and bad drainage, CA, FL.

Greasy Spot. Black Melanose, Cause unknown, CA, TX; chiefly grapefruit.

Gummosis. Gum Spot; Gummosis. Environmental injuries in part.

Leprosis. Florida Scaly Bark; Nailhead Rust. Cause unknown, FL.

Mottle Leaf. Zinc deficiency, AZ, CA, FL.

Oleocellosis. Rind-oil Spot. Chemical injury from release of oil in rind.

Rumple. Rind network on lemon; cause unknown.

Silver Scurf. Thrips injury on fruit, widespread; Silvering. Rust mite injury; Stigmonose. Insect punctures.

Wilt; Blight; Leaf Curl. Irregular water supply, FL.

POWDERY MILDEW. **Oidium** sp., CA, FL; **O. tingitaninum**.

ROT, Black, of Fruit. **Alternaria citri**, widespread.

ROT, Brown; Gummosis. **Phytophthora citrophthora**, AZ, CA, FL; **P. parasitica**, "mal di gomma," CA, FL.

ROT, Charcoal. **Macrophomina phaseoli**, AZ, CA.

ROT, Cottony Fruit; Twig Blight. **Sclerotinia sclerotiorum**, CA, FL, TX.

ROT, Dothiorella; Bark Canker. **Botryosphaeria ribis**, widespread.

ROT. **Diplodia**; Collar; Twig Blight. **Diplodia natalensis**, general.

ROT, Fruit. **Aspergillus** spp.; **Fusarium** spp.; **Mucor** spp.; **Oospora citri aurantii**, sour rot, **Nematospora coryli**, dry rot; **Candida krusei**.

ROT, Fruit. **Gloeosporium foliicolum** (*Glomerella cingulata*), FL.

ROT, Gray Mold; Twig Blight. **Botrytis cinerea**, CA.

ROT, Green Mold. **Penicillium digitatum**; Blue Mold, CA; **P. italicum**; Pink Mold, **P. roseum**, cosmopolitan; Black Mold, **Rhizopus stolonifer**; **Trichothecium viride**, occasional.

ROT. Melanose; Phomopsis; Decorticosis; Shell Bark. **Diaporthe citri**, general.

ROT, Mushroom Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL.

ROT, Root. **Fusarium solani**; **Phymatotrichum omnivorum**, TX; **Poria vaporaria**, CA; **Thielaviopsis basicola**.

ROT, Wood. **Daldinia concentrica**, occasional; **Ganoderma lucidum**, FL; **Polyporus** spp.; **Schizophyllum commune**; **Trametes hydnoides**; **T. hispida**.

SOOTY MOLD, **Capnodium citri**; **C. citricola**. Gulf states.

SPOT ANTHRACNOSE; Citrus Scab. **Elsinoë fawcettii**, AL, CA, FL, LA, MS.

VIRUS. **Algerian Navel Orange**, FL; **Citrus Ringspot**, CA, FL.

VIRUS. **Citrus Exocortis** (viroid); **Citrus Psorosis**, Scaly Bark; **Citrus Tatter Leaf**; **Citrus Tristeza**, Quick Decline; **Citrus Vein Enation**; **Citrus Xyloporosis**, Cachexia; **Citrus Yellow Vein**; **Citrus Leaf Rugose**, CA; **Citrus Tristeza**, LA; **Citrus Variegation**; **Citrus Leprosis**; **Citrus Enation**-Woody Gall, CA.

In the home garden oil sprays for scale help to get rid of sooty mold. A neutral copper spray just before growth starts is recommended in Florida for citrus scab and one just after flowering for melanose. Citrus trees in the burrowing nematode area are being pulled and the soil treated. Consult the California and Florida Agricultural Experiment Stations for the latest information on specific Citrus problems.

CLARKIA

ANTHRACNOSE, **Colletotrichum** sp. , PA.

BACTERIAL, MLO. **Aster Yellows**, NY, and **California Aster Yellows**, CA.

BLIGHT, Gray Mold; Canker. **Botrytis cinerea**, CA, NY.

DAMPING-OFF. **Pythium debaryanum**, CA; **Rhizoctonia solani**, CT.

DOWNY MILDEW. **Peronospora arthuri**, CA.

GALL, Leaf. **Synchytrium fulgens**, CA.

LEAF SPOT. **Alternaria tenuis**, secondary.

ROT, Stem. **Fusarium** sp., CA; **Phytophthora cactorum**, NY.

RUST. **Puccinia oenotherae** (0, I, II, III), CA, ID, NV, OR, WA; **Puccinia-strum pustulatum** (II, III), AK, NY.

WILT. **Verticillium albo-atrum**, CA.

CLAUSENA (Wampi)

LEAF SPOT. **Glomerella cingulata**, MD.

NEMATODE, Citrus. **Tylenchulus semipenetrans**, FL.

SPOT ANTHRACNOSE; Citrus Scab. **Elsinoë fawcettii**, FL.

CLAYTONIA (Spring Beauty)

DOWNY MILDEW. **Peronospora claytoniae**, CA, IA, MD, TX, WA.
GALL, Leaf. **Physoderma claytoniana**; MI, WI.
LEAF SPOT. **Ramularia claytoniae**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia marie-wilsoniae** (0, I, III), NH to VA, CO, MO, UT, WA, WI; **P. agnita** (0, III); **Uromyces claytoniae** (0, I, III), NY.
VIRUS. **Spring Beauty Latent**, AR.

CLEMATIS (including Virgins-Bower)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MN, TX.
BLIGHT, Leaf. **Phloeospora adusta**, TX.
LEAF SPOT. **Ascochyta clematidina**, widespread; **Cercospora rubigo**, CA, WA; **C. squalidula**, widespread; **Cylindrosporium clematidis**, East and South; **Glomerella cingulata**, FL; **Phyllosticta clematidis**, MT, VA; **Ramularia clematidis**, MT; **Septoria clematidis**, WA, WI; **Sphaerella applanata**, MT, TX.
NEMATODE, Root Knot. **Meloidogyne hapla**, ND.
POWDERY MILDEW. **Erysiphe polygoni**, widespread.
RUST. **Puccinia recondita** (0, I), Rocky Mts. and Pacific Coast; II, III on grasses; **P. pulsatillae** (III), CA; **P. stromatica** (III), AL; **Tranzschelia viornae** (II, III), TX.
SMUT. **Urocystis carcinodes**, UT.

CLEOME (Spider-Flower)

DOWNY MILDEW. **Peronospora parasitica**, LA.
LEAF SPOT. **Cercospora cleomis**, MI, NJ; **C. conspicua**; **Heterosporium hybridum**, IA, MT.
NEMATODE, Root Knot. **Meloidogyne** sp.
RUST. **Puccinia aristidae** (0, I), AZ, CO, IN, MT, NE, NM; II, III on grasses.

CLERODENDRUM (Glorybower)

CANKER, Stem. **Kutilakesa pironii**, FL.
LEAF SPOT. **Septoria phylctaenioides**, SC; **Cercospora apii** f. sp. **clerodendri**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., MD.
VIRUS. **Zonate Ring Spot**, FL.

CLETHRA (Sweet Pepperbush, White-Alder)

GALL, Red Leaf. **Synchytrium vaccinii**, NJ.
LEAF SPOT. **Phyllosticta clethricola**, MD, NJ, TX.
ROT, Root. **Corticium galactinum**.

CLINOPODIUM (Basil-Weed)

LEAF SPOT. **Phyllosticta decidua**, NY.
RUST. **Puccinia menthae** (0, I, II, III), MA to VA, CO, WI.

CLINTONIA

GALL, Leaf; False Rust. **Synchytrium aureum**, WI.
ROT, Leaf. **Ceratobasidium anceps**, ME, NY, WI.
RUST. **Puccinia mesomajalis** (III),CA, ID, MI, MN, MT, NH, NY, OR, TN, VA, WA, WI.

CLIVIA

NEMATODE, Spiral. **Rotylenchus brachyurus**.

CLOVER (*Trifolium incarnatum, T. pratense, T. repens, T. stoloniferum, T. subterraneum, T. vesiculosum*)

BLACK SPOT, **Pseudomonas andropogonis**, NC.
BLIGHT, Root; Crown Rot. **Pythium ultimum**; **P. irregulare**; **Fusarium proliferatum**; **Rhizoctonia solani**, GA, TX.
LEAF SPOT. **Cercospora zebrina**, TX.

NEMATODE, Root-Knot. **Meloidogyne graminicola**, MS.
VIRUS. **Clover Yellow Mosaic**; **Crimson Clover Latent**; **Cucumber Mosaic**; **Peanut Stunt**, MO; **Red Clover Vein Mosaic**; **Suberranean Clover Red Leaf**, CA; **White Clover Mosaic**; **Alfalfa Mosaic**, WI.

COCCOLOBA (Sea-Grape, Dove-Plum)

BLACK MILDEW. **Lembosia coccolobae**; **L. philodendri**; **L. portoricense**; **L. tenella**, FL.
LEAF SPOT. **Pestalotia coccolobae**, FL.
RUST. **Puccinia canaliculata**, GA.
RUST. **Uredo coccolobae**; **U. uviferae** (II), FL.

COCKLEBUR (*Xanthium*)

DOWNY MILDEW. **Plasmopara halstedii**, ND.
NEMATODE, Root Knot. **Meloidogyne hapla**.
ROT, Stem. **Sclerotinia trifoliorum**, MD; **S. sclerotiorum**, MD; **S. minor**, MD.
RUST. **Puccinia canaliculata**, KS; **P. xanthii**, KS.

COCKSCOMB (*Celosia argentia*)

DAMPING-OFF. **Rhizoctonia solani**, CT.
LEAF SPOT. **Cercospora celosiae**, AL, OK; **Phyllosticta** sp., NJ; **Alternaria** sp., NJ.
NEMATODE, Root Knot. **Meloidogyne** sp., KS, OH, TX.
ROT, Charcoal. **Macrophomina phaseoli**, TX.
VIRUS. **Beet Curly Top**, CA, TX.
VIRUS. **Cucumber Mosaic**, NY.

COCOA (*Theobroma cacas*)

GALL. **Agrobacterium tumefaciens**, FL.

COCOA-PLUM (*Chrysobalanus*)

LEAF SPOT. **Cercospora chrysobalani**, FL.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL.

COCOYAM (*Xanthosoma*)

BACTERIAL Leaf Spot. **Xanthomonas campestris** pv. **dieffenbachiae**, FL.

CODONANTHE

VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

COFFEE-BERRY (*Rhamnus californicus*)

BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, CA.
LEAF SPOT. **Phaeosphaerella rhamni**, CA.
RUST. **Puccinia mesneriana** (III), CA.
SOOTY MOLD. **Capnodium** sp., CA.

COLEUS

BROOMRAPE. **Orobanche ramosa**, NY.
DAMPING-OFF; Cutting Rot. **Pythium** spp., CA, MD; **Rhizoctonia solani**, FL, IL, NY, TX.
DOWNY MILDEW. **Peronospora lamii**, LA, NY.
LEAF SPOT. **Alternaria** sp., NJ; **Phyllosticta** sp., NJ.
NEMATODE, Leaf. **Aphelenchoides fragariae**, NJ.
NEMATODE, Root Knot. **Meloidogyne** spp., AL, CA, CT, MD, MO, NJ, NY, OK.
NONPARASITIC. **Crinkle**. Genetic leaf deformity.
ROT, Gray Mold; Leaf Blight. **Botrytis cinerea**, AK, MO.
SLIME MOLD. **Badhamia panicea**, KS.
VIRUS. **Coleus Mosaic**.
WILT. **Verticullium** sp., CT.

COLLARDS

(▶ Cabbage)

Subject to downy mildew and Sclerotinia rot.

COLLINSIA (Blue-Lips, Blue-Eyed Mary)

LEAF SPOT. **Septoria collinsiae**, IL.
ROT, Root. **Pythium mamillatum**, CA.
RUST. **Aecidium insulum** (0, I), UT; **Puccinia collinsiae** (0, I, II, III), CA, OR, UT, WA.
SMUT, White. **Entyloma collinsiae**, CA, OR.

COLLINSONIA (Horse-Balm)

BLACK SPOT, on stem. **Phyllachora** sp., PA.

COLLOMIA

POWDERY MILDEW. **Sphaerotheca macularis**, CA, CO, ID, MT, ND, WA, WY.
NEMATODE, Bulb. **Ditylenchus dipsaci**, Pacific Northwest.
RUST. **Puccinia giliae** (II, III), CA, WA; 0, I unknown; **P. plumbaria** (0, I, III), NV; **Uromyces acuminatus** var. **polemonii** (0, I), CO, NE, ND; II, III on marsh grass.

COLTSFOOT (*Tussilago*)

LEAF SPOT. **Mycosphaerella tussilaginis**, NY; **Septoria farfaricola**, TN.

COLUMBINE (*Aquilegia*)

BLIGHT, Gray Mold. **Botrytis cinerea**; **B. streptothrix**.
DAMPING-OFF; Root Rot. **Rhizoctonia solani**, IL.
LEAF SPOT, **Ascochyta aquilegiae**, CT, IL, IA, NJ, NY, PA, TX, WI; **Cercospora aquilegiae**, KS, OR; **Septoria aquilegiae**, CT, IN, MI, NY, OH, VT, VA, WI; **Haplobasidium pavoninum**, AK.

NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Erysiphe polygoni**, AK, IL, IN, IA, NJ, NY, OH, PA, TX, UT, WI, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium mamillatum**, CA; **Phytophthora dreschleri**, NC.
ROT, Stem. **Phoma** sp., PA; **Sclerotinia sclerotiorum**, DE, OH, PA, TX; **Phyllosticta aquilegicola**, WA.
RUST. **Puccinia recondita** (0, I), CA, CO, ID, NM, OR, WA; II, III on grasses.
SMUT, Leaf and Stem. **Urocystis sorosporioides**, UT.
VIRUS. **Cucumber Mosaic**, OH; **Mosaic**, unidentified, IA, KS.

COLUMBO (*Frasera*)

LEAF SPOT. **Asteroma fraserae**, black mildew, CO, ID; **Cercospora fraserae**, CO, UT; **Marssonina fraserae**, ID, WA; **Phyllosticta fraserae**, CO.
RUST. **Uromyces speciosus** (II, III), CO, NM; 0, I, unknown.

COLUMNEA

VIRUS. **Tomato Spotted Wilt**, PA.

COMMELINA (C. diffusa)

VIRUS. **Aneilema Mosaic**, FL; **Commelina Mosaic**, FL; **Cucumber Mosaic**, FL; **Tradescantia/Zebrinia Mosaic**, FL.

CONFEDERATE-JASMINE (*Trachelospermum*)

BLACK MILDEW; Sooty Mold. **Dimerosporium pulchrum**, LA.
LEAF SPOT. **Cercospora repens**, LA.
ROT, Root. **Clitocybe tabescens**, FL.

CORAL-BELLS

► Heuchera.

CORALBERRY (*Symphoricarpos orbiculatus*)

CANKER; Stem Gall. **Phomopsis** sp., MD.
LEAF SPOT. **Cercospora symphoricarpi**, KS, NE, TX.
POWDERY MILDEW. **Microsphaera diffusa**, general.
ROT, Berry. **Alternaria** sp., CT.
ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia crandallii** (0, I), KS, MO, OK.
SPOT ANTHRACNOSE. **Sphaceloma symporicarpii**.

CORDIA

POWDERY MILDEW. **Golovinomyces cichoracearum**, TX.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

COREOPSIS (Tickseed)

BACTERIAL, MLO. **Aster Yellows**, NJ, NY, and **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, TX.
BROOMRAPE. **Orobanche ramosa**, TX.
DODDER. **Cuscuta** sp., NJ.
LEAF SPOT. **Cercospora coreopsidis**, OK; **Phyllosticta coreopsidis**, WI; **Septoria coreopsidis**, IA, WI, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
POWDERY MILDEW. **Golovinomyces cichoracearum**, MD, MN, NY, WI.
ROT, Root. **Rhizoctonia solani**, MN, NY, TX; **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, OH, WA.
RUST. **Coleosporium inconspicuum** (II, III), GA, MD, NC, OH, SC, TN, VA, WV; 0, I on pine.
SCAB. **Cladosporium coreopsidis**.
VIRUS. **Beet Curly Top**, CA.
WILT. **Verticillium albo-atrum**, NY.

CORIANDER (*Coriandrum*)

ANTHRACNOSE. **Gloesporium** sp., MD.
BACTERIAL Leaf Spot. **Pseudomonas syringae**, CA, FL; **Xanthomonas campestris** pv. **carotae**, OR.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
VIRUS. **Coriander Feathery Red Vein**, CA.
WILT. **Fusarium oxysporum** f. sp. **coriandrii**, CA.

CORN, SWEET (*Zea mays* var. *saccharata*)

BACTERIAL Leaf Blight. **Acidovorax avenae** syn. **Pseudomonas avenae**, IL.
BACTERIAL Leaf Stripe. **Pseudomonas andropogonis**, FL.
BACTERIAL Spot. **Pseudomonas syringae**, MA.
BACTERIAL Stalk Rot. **Erwinia dissolvens**, FL, WV.
BACTERIAL Wilt. **Erwinia stewartii**, general.
BLIGHT, Leaf. **Helminthosporium turcicum** syn. **Exserohilum turcicum**), HI, IL, TX; middle Atlantic and southern states, occasional in central states; **H. maydis** (*Cochliobolus heterostrophus*), southern leaf blight.
BLIGHT, Seedling; Stalk Rot; Ear Rot. **Penicillium oxalicum**.
DOWNY MILDEW. **Peronosclerospora sorghi**, IL.
LEAF SPOT. **Cercospora zeae-maydis**, VA, Ontario, Canada; **Phaeosphaeria maydis**, FL; **Physoderma maydis**, brown spot, in South; Eyespot, **Kabatiella zeae**.
LESIONS, Stem. **Rhizoctonia solani**, MS.
NEMATODE, Lesion. **Pratylenchus penetrans**.
NEMATODE, Root Knot. **Heterodera zeae**, VA; **Meloidogyne chitwoodi**, Pacific NW; **M. hapla**, Pacific NW.
ROT, Black Bundle Disease. **Cephalosporium acremonium**, MT.
ROT, Dry Ear. **Nigrospora sorghi**, IA.
ROT, Ear, Root and Stalk; Seedling Blight. **Diplodia zeae**, ME to VA, SD, TX; **Fusarium** spp.; **F. moniliforme**, cosmopolitan.
ROT, Root. **Gibberella zeae**, chiefly east of Mississippi River; **Phoma terrestris**, DE, MD; **Pythium** spp., IL, IA, OH, TX; **Helminthosporium pedicellatrum**, CA.

RUST. **Puccinia sorghi** (II, III), general; 0, I on oxalis; **P. polysora**, southern.
SMUT. **Ustilago maydis**, general, FL, IL, MI, MN, NY, TX, WI; **Sphacelotheca reiliana**, Head Smut.
SMUT, False. **Ustilaginoidea virens**, MS.
VIRUS. **Barley Yellow Dwarf** IL; **Corn Leaf Fleck**; **Corn Mosaic**, **Corn Stunt**, AL, AZ, CA, GA, IN, KY, MO, SC; **Wheat Streak Mosaic**, CO, ID, IN, KS, MI, NE, OH, TX, UT; **Cucumber Mosaic**, celery strain.
VIRUS. **Maize Chlorotic Mottle**, HI, KS, NE; **Maize Dwarf Mosaic**, AL, AZ, AR, CA, GA, ID, IA, MO, NJ, NM, NY, OH, PA, WA; **Maize Rayado Fino**; **Maize Stripe**, FL; **Sorghum Stunt Mosaic**, CA.
WITCHWEED. **Striga asiatica**, on roots, NC.

Smut is the most conspicuous corn disease in home gardens. Bacterial wilt is dependent on survival of insect vectors and may be serious after a warm winter unless resistant hybrids are used.

CORNCOCKLE (*Agrostemma*)

LEAF SPOT. **Gloeosporium** sp., IN; **Marssonina delastrei**, IL, IN, MI, MS, MO; **Septoria lychnidis** var. **pusilla**, ND.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Fusarium** sp., IN.

CORN-MARIGOLD (*Chrysanthemum segetum*)

BACTERIAL, MLO. **California Aster Yellows**, CA.
LEAF SPOT. **Septoria chrysanthemi**, NY.

CORYDALIS

DOWNY MILDEW. **Peronospora corydalis**, IN, MD, MA, OK, TX.
LEAF SPOT. **Septoria corydalis**, TX, WI.
NEMATODE. **Meloidogyne** sp., FL.
RUST. **Puccinia aristidae** (0, I), CO, KS, NE; II, III on grasses; **P. brandegei** (III) CO, WA.

COSMOS

BACTERIAL, MLO. **Aster Yellows**, DE, NJ, NY, and **California Aster Yellows**, CA.
BACTERIAL Wilt. **Pseudomonas solanacearum**, NC.
BLIGHT, Southern. **Sclerotium rolfsii**, MS.
CANKER, Stem Blight. **Diaporthe stewartii**, CT to NJ, CA, KS, SD, TX.
DODDER. **Cuscuta** sp., NY.
LEAF SPOT. **Cercospora** sp., TX; **Septoria** sp., CT.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, MD, NE, NC, TX.
ROT, Root. **Phymatotrichum omnivorum**, AZ, TX; **Macrophomina phaseoli**, TX; **Pythium** sp., MD; **Rhizoctonia solani**, CT, MD, TX.
VIRUS. **Beet Curly Top**; **Mosaic**, unidentified, FL, TX; **Tomato Spotted Wilt**, TX.
WILT. **Fusarium** sp., NJ.

COTONEASTER

BACTERIAL Fire Blight. **Erwinia amylovora**, widespread.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, central states.
CANKER, Twig Blight. **Physalospora obtusa**, NY to OH, TX; **Diplodia** sp., TX; **Gibberella baccata**, CA.
LEAF SPOT. **Fabraea maculata**, CA, IA; **Phyllosticta cotoneastri**, MD; **P. cydoniae**, MS.
POWDERY MILDEW. **Podosphaera** sp., CA.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, AZ, TX; **Phytophthora** sp.
SCAB. **Venturia** sp., WA.

COTTON (*Gossypium*)

CANKER, Stem. **Phoma exigua**, NC, VA.
NEMATODE. **Rotylenchus reniformis**, VA.
ROT, Lint. **Nigrospora oryzae**, AL.
ROT, Root. **Rhizoctonia solani**, MS.
ROT, Stem. **Sclerotinia sclerotiorum**, ND.

COURSETIA

RUST. **Phragmopyxis acuminata** (0, III), AZ, CA.

COWANIA

RUST. **Phragmidium andersonii** (I, II, III), ID.

COWPEA (*Vigna sinensis*)

LEAF AND STEM DISEASE. **Cercospora cebrina** (clover isolate), NC.
POD SPOT, Black; Seed. **Phomopsis longicolla**, MS.
ROT, Root. **Phytophthora megasperma**, NC.
VIRUS. **Brome Mosaic**, CA; **Cowpea Aphid-Borne Mosaic**, AR; **Cowpea Severe Mosaic**, AR, IN, LA.
WILT. **Fusarium oxysporum** f. sp. **tracheiphilum**, CA.

Cowpeas are of most interest to gardeners as a green manure crop, and there is little need of repeating here the long list of possible diseases, most of which are given under Bean. Ashy stem blight, charcoal rot, is fairly serious. The root-knot nematode is general, but varieties Iron and Bragham are almost immune. Fusarium wilt, general in the South, is largely controlled by using resistant varieties. Leaf spots are numerous, and some may cause defoliation. Rust is widespread on Blackeye and related varieties, but many varieties are resistant.

CRABAPPLE, FLOWERING (*Malus*)

ANTHRACNOSE. Northwestern. **Neofabraea malicorticis**, OR.
BACTERIAL Fire Blight. **Erwinia amylovora**, widespread.
BLIGHT, Thread. **Pellicularia koleroga**, LA.
BLOTCH, Sooty. **Gloeodes pomigena**, IN.
CANKER, Blister. **Nummularia discreta**, WV.
CANKER, Coral Spot; Twig Blight. **Nectria cinnabarina**, AK.
CANKER; DIEBACK. **Valsa leucostoma**, WV; **Physalospora obtusa**, MI; **Sphaeropsis pyriputrescens**, WA; **Phacidiopycnis washingtonensis** (also Fruit Rot), WA.

LEAF SPOT. **Cercosporella pirina**, IL, WI; **Coniothyrium pirinum**, WI; **Fabraea maculata**, AK, MD; **Illosporium malifoliorum**, WV; **Marssonina coronaria**, IN, IA, MO, WI; **Phyllosticta** sp., IA; **P. solitaria**, IN, IA, KS, OH, TX, WV; **P. zonata**, IA; **Septoria pyri**.

MISTLETOE, European. **Viscum album**, CA.

POWDERY MILDEW. **Oidium pyrinum**, WI; **Phyllactinia corylea**, WA; **Podosphaera leucotricha**, IL, IA; **P. oxyacanthae**, WA, WI.

ROT, Black, fruit, leaf spot. **Physalospora obtusa**, eastern and central states.

ROT, Heart. **Ganoderma applanatum**.

ROT, Root. **Armillaria mellea**, WA; **Phymatotrichum omnivorum**, TX.

RUST. **Gymnosporangium clavipes**, CT, NJ; **G. globosum**, AL, IN, KS, NJ, SC, VA; **G. juniperi-virginianae**, cedar-apple rust, general; **G. libocedri**, AK, OR; **G. nelsonii**, AK, WA; **G. nootkatense**, AK.

SCAB. **Venturia inaequalis**, general.

SCAB, Twig Infections. **Venturia inaequalis**, MA, OH, PA, RI.

Cedar-apple rusts are common and injurious on most native crabapples; asiatic varieties are usually resistant. Remove red-cedars in the vicinity.

CRANBERRY (*Vaccinium*, subgenus *Oxycoccus*)

DIEBACK. **Diaporthe vaccinii**, WI.

GALL, Red Leaf. **Synchytrium vaccinii**, NJ.

GALL; Shoot Hypertrophy; Rose-bloom. **Exobasidium vaccinii**, general; **E. oxycocci**, MA.

LEAF SPOT. **Discohainesia oenotherae**, also storage rot, MA, NJ, OR, WA, WV; **Mycosphaerella nigromaculans**, black spot, OR, WA; **Phyllosticta putrefaciens**, also berry rot, MA, NJ; **Ramularia multiplex**, MI, NY, WI; **Venturia compacta**, leaf smudge, general; **Cladosporium oxycocci**, leaf mold, NJ, WA.

NEMATODE. **Atylenchus decalineatus**.

NEMATODE, Sheath. **Hemicycliophora similis**.

NEMATODE, Stubby Root. **Paratrichodorus christiei**.

POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, AL, NJ, OH.

ROT, Berry; Blotch. **Acanthorhynchus vaccinii**, ME to NC, WI, OR, WA; **Ceuthospora lunata**, black rot, MA, NJ, OR, WA, WI; **Curvularia inaequalis**, IL, NJ, WI; **Sphaeronema pomorum**, NJ; **Sporonema oxycocci**, AK, ME, MA, NJ, OR, WA, WI.

ROT, Berry Speckle. Several fungi associated.
ROT, Bitter; Leaf Spot. **Glomerella cingulata** var. **vaccinii**, general; **Phyllosticta vaccinii**, WI.
ROT, Early; Scald, Blast. **Guignardia vaccinii**, general; **Phyllosticta vaccinii**, WI.
ROT, End. **Godronia cassandrae**, general.
ROT, Fairy Ring; Root. **Psilocybe agrariella** var. **vaccinii**, MA, NJ.
ROT, Hard; Twig Blight. **Monilinia oxycocci**, MA, ME, OR, WA, WI.
ROT, Root; DIEBACK. **Phytophthora cinnamomi**, MA.
ROT, Storage. **Penicillium** spp., cosmopolitan; **Diaporthe vaccinii**, general; **Botrytis cinerea**, gray mold, also blossom blight; **Alternaria** sp.; **Dematium** spp.; **Melanospora destruens**, in market; **Gloeosporium minus**, MD, NJ; **Pestalotia vaccinii**; **Stemphylium ilicis**.
ROT, Witches' Broom. **Naevia oxycocci**, ME, MI, NH, NY.
RUST. **Pucciniastrum vaccinii** (II, III), OR, UT, WA; 0, I on hemlock.
VIRUS. **Cranberry False-Blossom**, ME to NJ, OR, WA, WI.
VIRUS. **Cranberry Ring Spot**, WI.

CRAPE-MYRTLE (*Lagerstroemia*)

BLIGHT, Thread. **Rhizoctonia ramicola**, FL.
LEAF SPOT. **Cercospora lythracearum**, TX; **Cercospora** sp., blotch, FL, TX; **Phyllosticta lagerstroemiae**, tip blight, LA, TX.
NONPARASITIC. **Chlorosis**. Manganese deficiency.
POWDERY MILDEW. **Uncinuliella australiana**, general; **Phyllactinia corylea**, AL.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
SOOTY MOLD. **Capnodium** spp., in aphid honeydew.
Mildew is serious on crape-myrtle, calling for sprays as the buds break.

CRASSULA

ANTHRACNOSE. **Gloeosporium** sp., NJ.
LEAF SPOT. **Phomopsis** sp., CT.
NEMATODE, Leaf. **Aphelenchoides** sp.
ROT, Root. **Armillaria mellea**, CA; **Pythium** sp., NJ, NY.

CREEPING ZINNIA (*Sanvitalia procumbens*)

VIRUS. **Sunflower Mosaic**, TX.

CREOSOTE BUSH (*Larrea*)

BLIGHT. **Omphalia** sp.
MISTLETOE. **Phoradendron californicum**, TX to CA.

CRINUM

LEAF SCORCH; Red Blotch. **Stagonospora curtisii**, CA, NY.
LEAF SPOT. **Cercospora pancratii**, AL, FL, MS.
VIRUS. **Mosaic**. Unidentified.

CROCUS

BACTERIAL Scab. **Pseudomonas marginata**, occasional on imported stocks.
ROT. Corm. **Fusarium oxysporum**, NY, PA; **Stromatinia gladioli**, dry rot, widespread; **Penicillium** sp., blue mold.
VIRUS. **Iris Mosaic**, CA, MD.

CROTALARIA (*C. retusa*)

BLIGHT, Seedling. **Alternaria cassiae**, MS.
POWDERY MILDEW. **Oidium erysiphoides** var. **crotalariae**, LA, MS.
VIRUS. **Potato Virus X**, on *C. juncea*.
WILT; Root Rot. **Fusarium** sp., GA, TX.
This species is sometimes grown as an ornamental. Crotalaria as a cover crop has more diseases, but *C. spectabilis* is immune to root-knot nematode and so particularly useful between susceptible crops.

CROTON (*Codiaeum*)

ANTHRACNOSE. **Gloeosporium** spp., FL, NJ.
ROT, Root. **Phymatotrichum omnivorum**, TX.
This is the croton of florists.

CROTON (*Croton*)

DODDER. **Cuscuta indecora**, TX.
GALL, Leaf. **Kutilakesa pironii**, FL.
LEAF SPOT. **Cercospora capitati**, TX; C. **crotonicola**, SC, TX; **C. crotonis**, AL, FL, SC; **C. crotonophila**, WI; **C. maritima**, MS; **C. crotonifolia**, SC.
NEMATODE, Lesion. **Pratylenchus** sp., FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Bubakia crotonis** (II, III), KY to AL, AZ, CA, FL, NE, TX.

CROWBERRY (*Empetrum*)

RUST. **Chrysomyxa empetri** (II, III), ME, NH, NY.

CROWN VETCH (*Coronilla varia*)

NEMATODE. **Meloidogyne** sp., VA.
ROT, Stem. **Sclerotinia trifoliorum**; **Fusarium roseum**.

CRYPTANTHA

GALL, Leaf. **Synchytrium myosotidis**, AZ, CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, NV.
RUST. **Puccinia aristidae** (0, I); II, III on native grasses; **P. cryptanthes**, CA, WA.

CRYPTANTHUS

ANTHRACNOSE. **Gloeosporium** sp., WA.

CRYPTOMERIA

BLIGHT, Leaf and Twig. **Diaporthe eres**; **Phyllosticta cryptomeriae**, VA and general U.S.
LEAF SPOT. **Pestalotia cryptomeriae**, SC; **P. funerea**, NJ.

CUCUMBER (*Cucumis sativus*)

ANTHRACNOSE. **Colletotrichem lagenarium**, general.

BACTERIAL Angular Leaf Spot. **Pseudomonas syringae** pv. **lachrymans**, general.

BACTERIAL Soft Rot. **Erwinia aroideae**; **E. carotovorus**.

BACTERIAL Spot. **Xanthomonas cucurbitae**, MA, MI.

BACTERIAL Wilt. **Erwinia tracheiphila**, general.

BLIGHT, Blossom; Fruit Rot. **Choanephora cucurbitarum**, FL, GA, NJ, OK, RI, TX.

BLIGHT, Gummy Stem; Black Fruit Rot. **Mycosphaerella citrullina**, widespread; **M. melonis**, AZ.

BLIGHT, Leaf. **Alternaria cucumerina**, general.

BLIGHT, Southern. **Sclerotium rolfsii**, VA to FL, TX.

DAMPING-OFF. **Rhizoctonia solani**, also stem rot; **Pythium** spp.

DODDER. **Cuscuta gronovii**, NY.

DOWNY MILDEW. **Pseudoperonospora cubensis**, general.

LEAF SPOT. **Cercospora cucurbitae** AL, DE, IA, NJ, TX, WI; **Ascochyta** sp., OR; **Gloeosporium** sp. IL; **Phyllosticta cucurbitacearum**, DE, OH, TX; **Septoria cucurbitacearum**, DE, MA, NH, PA; **Stemphylium cucurbitacearum**, OH; **Alternaria consortiale**, WA; **Ulocladium cucurbitae**, CA, NY.

MOLD. Seed. **Alternaria tenuis**, cosmopolitan; **Curvularia trifolii**, NJ.

NEMATODE, Hop Cyst. **Heterodera humuli**, OR.

NEMATODE, Root Knot. **Meloidogyne incognita**; **M. javanica**.

NONPARASITIC. **Chlorosis**. Nitrogen, manganese, or potassium deficiency.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Sphaerotheca fuliginea**, CA, NC; **Leveillula taurica**, ID.

ROT, Charcoal. **Macrophomina phaseoli**, IL.

ROT, Fruit. **Fusarium** spp., TX; **Rhizopus stolonifer**, occasional. **Diplodia natalensis**; **Botrytis cinerea**.

ROT, Root. **Fusarium solani** f. sp. **radicicola**, CT, OR, WA; **Phymatotrichum omnivorum**, TX.

ROT, Stem; Fruit. **Sclerotinia sclerotiorum**, occasional.

SCAB. **Cladosporium cucumerinum**, general.

VIRUS. **Bromegrass Mosaic Virus**, general.

VIRUS. **Cucumber Mosaic**, general; **Beet Curly Top**, CA, ID, OR, TX, UT, WA; **Tobacco Ring Spot**, MD, PA, VA; **Zucchini Yellow Mosaic**, CA, FL, NY; **Cucurbit Leaf Curl**, AZ, NM, TX.

WILT. **Fusarium oxysporum** f. sp. **cucumerinum**, FL; **F. oxysporum** f. sp. **cucurbitae**; **Verticillium albo-atrum**, CA.

WILT, Basal Stem Lesions. **Phytophthora capsici**, Mexico.

Starting cucumbers under Hotkaps and then treating to control insect vectors helps to reduce bacterial wilt and virus diseases. Choose varieties resistant to mosaic and scab.

CULVERS-ROOT (*Veronicastrum*)

LEAF SPOT. **Cercospora leptandrae**, WI; **Phyllosticta decidua**, TX, WI; **Ramularia veronicae**, TX; **Septoria veronicae**, WI.

POWDERY MILDEW. **Golovinomyces cichoracearum**, IL; **Sphaerotheca macularis**, CT, IL, IA, MD, MI, MO, WI.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX.

RUST. **Puccinia veronicarum** (III), IA, TX, WI.

CUNNINGHAMIA

LEAF SPOT. Necrotic. **Phomopsis** sp., OR.

CUPHEA

BLIGHT, Gray Mold. **Botrytis cinerea**, occasional in greenhouses.

LEAF SPOT. **Septoria maculifera**, NY, PA, VA, WV.

NEMATODE, Root Knot. **Meloidogyne** sp., MD.

POWDERY MILDEW. **Erysiphe polygoni**, MD, VA.

ROT, Root. **Rhizoctonia solani**, IL.

WILT, Root Rot. **Sclerotinia sclerotiorum** MN, ND.

CURRANT (*Ribes* spp.)

ANTHRACNOSE; Fruit Spot. **Pseudopeziza ribis**, general.

BLIGHT, Cane. **Bostryosphaeria ribis** var. **chromogena**, general.

BLIGHT, Gray Mold; Fruit Spot. **Botrytis cinerea**, Northeast, OR, WA.

BLIGHT, Thread. **Pellicularia koleroga**, FL.

CANKER, Cane Knot. **Thyronectria berolinensis**, CT to IN, KS, UT.

CANKER; DIEBACK. **Nectria cinnabarina**, ME to CO, WA; **N. ditissima**, MN, NY; Black Pustule, **Phragmodothella ribesia**, Northeast, Pacific Northwest.

DOWNY MILDEW. **Plasmopara viticola**, WI.

LEAF SPOT. **Alternaria** sp., MI; **Cylindrosporium ribis**, WI; **Mycosphaerella ribis**, ME to MD, AR, OR, WA.

LEAF SPOT, Angular. **Cercospora angulata**, NY to VA, KS, MN; **C. ribis**, AL, IN, IA.

POWDERY MILDEW. **Microsphaera grossulariae**, MT, NE, NH; **Sphaerotheca mors-uvae**, AK, CA, CT, MT, NE, OR, WA; **Phyllactinia corylea**, MI.

ROT, Berry. **Glomerella cingulata**, CT, PA.

ROT, Collar. **Fomes ribis**, NY to IN, MN, UT.

ROT, Root. **Armillaria mellea**, CA, OR, WA; **Phymatotrichum omnivorum**, TX; **Hypholoma perplexum**, NY.

RUST, White Pine Blister. **Cronartium ribicola** (II, III), ME to VA, IL, MN, OR, SD, WA. **Puccinia caricis** (0, I), CT, IN, MD, NY, II, III on Carex.

VIRUS. **Currant Mosaic**, MD, NY.

WILT. **Verticillum** sp., NY.

Black currant is the most important host of white pine blister rust and should not be grown; red currants should be kept at least 300 feet from pines. Cut out canes with cane blight.

CURRANT, FLOWERING (*Ribes*)

ANTHRACNOSE. **Pseudopeziza ribis**, IL, IA, MN, MT.

BACTERIAL Leaf Spot. **Pseudomonas ribicola**.

BLIGHT; DIEBACK. **Botrytis cinerea**, AK, IN.

CANKER; DIEBACK. **Botryosphaeria ribis**, KS; **Phragmodothella ribesia**, NY; **Thyronectria berolinensis**, KS; **Nectria cinnabarina**, AK, KS.

LEAF SPOT. **Cercospora angulata**, MN; **C. ribicola**, OR, WA; **Marssonina ribicola**, CO; **Mycosphaerella aurea**, NY to KS, SD, WA; **M. ribis**, NY to KS, MN, UT; **Phyllosticta grossulariae**, IN; **Septoria sanguinea**, WA.

RUST. **Coleosporium jonesii**, MN; **Cronartium occidentale**, MT to NM, CA, WA; **C. ribicola**, ME to MD, CO, MN, NV, Pacific states; **Melampsora ribesii-purpureae**; II, III on willow; **Puccinia caricina**, NY to IA, AK, CA, OR; **P. micrantha**; **P. parkerae**.

VIRUS. Viruslike vein-banding, CA, CT, MN, NJ, NY, OR, RI, WA.

CYCAD, SAGO-PALM (*Cycas*)

CORALLOID ROOTS. **Anabaena cycadearum** and **Nostoc commune**, algae, and bacterium *Azotobacter* are associated with roots but are mostly innocuous.

LEAF SPOT. **Ascochyta cycadina**, MO, TX; **Pestalotia cycadis** (secondary), CT, FL.

A destructive blight of unknown cause (but with *Gloeosporium* and *Phoma bresadolae* often associated with it) causes pale green areas on pinnae of young leaves, which are curled out of the flat plane and die back. The disease is apparently systemic and increases annually until death. Eradication of blighted plants is the only control suggested.

CYCLAMEN

BACTERIAL Tuber Rot. **Erwinia carotovora**, NJ, NY, OH.

BLIGHT; Bud and Leaf Rot; Petal Spot. **Botrytis cinerea**, cosmopolitan.

BLIGHT, Leaf and Bud. **Glomerella cingulata**, IN, MA, MO, NJ, OH, PA, TX, VA.

LEAF SPOT. **Phyllosticta cyclaminicola**, IL, OH, TX; **P. cyclaminis**, VA; **Systoria cyclaminis**, CA; **Colletotrichum gloeosporioides**, FL; also lesions on flowers and stems.

LEAF SPOT; Stunt; White Mold. **Ramularia cyclaminicola** (*Cladosporium cyclaminis*), CA, IL, MN, NJ, NY, OH, PA.

NEMATODE, Leaf. **Aphelenchoides fragariae**.

NEMATODE, Lesion. **Pratylenchus pratensis**, VA.

NEMATODE, Root Knot. **Meloidogyne** sp., cosmopolitan.

ROT, Root. **Thielaviopsis basicola**, CT.

VIRUS. **Impatiens Necrotic Spot**, NC.

WILT. **Fusarium oxysporum** f. sp. **cyclaminis**, CA, NJ; **Fusarium** sp., NJ.

Discard plants with stunt; sterilize soil and pots, and benches where diseased plants have grown. Avoid splashing to reduce Botrytis blight and leaf nematodes. Spray for blight and leaf spots with zineb or ferbam.

CYNOGLOSSUM (Hounds-Tongue)

BLIGHT, Southern. **Sclerotium rolfsii**, FL.
DOWNY MILDEW. **Peronospora cynoglossi**, IL, MD, TX.
LEAF SPOT. **Cercospora cynoglossi**, IN; **Phyllosticta decidua**, WI; **Ramularia lappulae**, WI, TX.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Golovinomyces cichoracearum**, UT, VA, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, WA, British Columbia, Canada.

CYPRESS (*Cupressus*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, AZ, CA, FL.
BLIGHT, Nursery. **Phomopsis juniperovora**, MD, NC, VA.
BLIGHT, Seedling. **Fusarium solani**, TX.
BLIGHT, Twig. **Coryneum asperulum**, AL; **C. berckmansii**, OR; **Cercospora thujina**, AL, GA, LA; **Pestalotia funerea**, CA, TX; **Botryosphaeria** sp., GA, on Arizona cypress.
CANKER; DIEBACK. **Coryneum cardinale**, on Monterey, sometimes Italian cypress; **Cytospora cenisia**, CA, on Italian cypress; **Macrophoma cupressi**, AL, CA, FL, TX; **Monochaetia unicornis**, GA, SC.
MISTLETOE. **Phoradendron** sp., AZ, CA, OR.
NEEDLE CAST. **Lophodermium** sp., NJ.
NEMATODE, Lesion. **Pratylenchus thornei**.
ROT, Heart. **Fomes pini**, CA.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX; **Phytophthora cinnamomi**, LA.
ROT, Wood. **Stereum taxodii**, cause of "pecky" cypress; **Coniophora puteana**, CA; **Lenzites saepiaria**, cosmopolitan; **Polyporus** spp.; **Poria subacida**; **Steccherinum ochraceum**.
RUST. **Gymnosporangium cupressi** (III), on Arizona cypress.

Coryneum canker has killed thousands of Monterey cypress trees in California, and Cytospora canker has been fatal in a narrow belt along the coast.

CYPRESS-VINE (*Quamoclit*)

NEMATODE, Root Knot. **Meloidogyne** sp., AL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium ipomoeae** (II, III), IL, SC, TN.
WHITE RUST. **Albugo ipomeae-panduratae**, MS, NM.

CYRILLA (Leatherwood)

CANKER, Brown Felt. **Septobasidium sinuosum**, FL.
LEAF SPOT. **Phyllosticta cyrillae**, FL.
RUST. **Aecidium cyrillae**, FL, LA, MS.

DAHLIA

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, IL.
BACTERIAL, MLO. **Aster Yellows**, MD.
BACTERIALRot. **Erwinia carotovora**, MS, WA; **E. cytolitica**, NY.
BACTERIAL Wilt. **Pseudomonas solanacearum**, DE, MI, MS, NJ, NC, OK, TX.
BLIGHT, Blossom. **Choanephora americana**, FL; **Stemphylium floridanum**.
BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan on flower buds.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, KS, MS, NJ, NC, TX.
LEAF SPOT. **Alternaria** sp., VA to AL, MO, MI, secondary; **Cercospora** sp., FL, MS.
NEMATODE, Bulb. **Ditylenchus destructor**, OR.
NEMATODE, Leaf. **Aphelenchoides ritzemabosi**, CA.
NEMATODE, Root. **Paratrichodorus pachydermus**, MI.
NEMATODE, Root Knot. **Meloidogyne** sp., NC to AL, AZ, CA, MO, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Ersiphe polygoni**, CA, DE, GA, IA, MO, NJ, PA, VA; **Uncinula** sp., NC.
ROT, Charcoal. **Macrophomina phaseoli**, OK, SC.
ROT, Root. **Armillaria mellea**, CA; **Phymatotrichum omnivorum**; TX.

ROT, Stem. **Sclerotinia sclerotiorum**, CA, ME, NY.
ROT, Stem, Root, Cutting. **Pythium** spp.; **Rhizoctonia solani**; **Fusarium roseum**.
SCAB. **Streptomyces scabies**, NC.
SMUT, Leaf. **Entyloma dahliae**, CA, NJ, OR.
VIRUS. **Dahlia Mosaic**, general; **Tomato Spotted Wilt**, CA, MI, NJ, NY, NC, OK, TX, WI; **Cucumber Mosaic**; **Tobacco Ring Spot**.
WILT. **Fusarium oxysporum**; **Verticillium albo-atrum** (*V. dahliae*) IL, MI, MO, NJ, OH, TX.

Leafhopper injury, hopperburn, looks like a true disease. Margins of leaves turn brown, and there may be general stunting and yellowing. The spotted wilt virus causes yellow ring spots in dahlia foliage. Heavy, wet soil contributes to bacterial and fungus rots and wilts. Mildew is often prevalent in late summer.

DAISY, OXEYE (*Leucanthemum vulgare*)

BACTERIAL, MLO. **Aster Yellows**, KS, NJ, NY.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Cylindrosporium chrysanthemi**, OK; **Septoria chrysanthemella**; **S. leucanthemi**, blotch, CT, NY.
NEMATODE, Root Knot. **Meloidogyne** sp.
NEMATODE, Stem. **Ditylenchus dipsaci**, NY.
ROT, Stem. **Fusarium roseum** and **F. solani**, TX; **Sclerotinia sclerotiorum**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Potato Yellow Dwarf**, NY.

DALIBARDA (Dewdrop)

LEAF SPOT. **Septoria dalibardae**, ME, MI, NH, NY, VT.

DANDELION (*Taraxacum*)

VIRUS. **Tomato Ringspot**, PA.

DAPHNE

BLIGHT, Twig. **Botrytis** sp., Northeast, Northwest.
DIEBACK; Wilt. **Fusarium** sp., NJ.
LEAF SPOT; Leaf Drop. **Gloeosporium mezerei**, WA; **Marssonina daphnes**.
ROT, Collar, Stem. **Phytophthora cactorum**, CA, NY; **Rhizoctonia solani**, NY.
ROT, Stem; Wilt. **Sclerotium rolfsii**, FL.

DATURA

BACTERIAL Canker, Vascular. **Clavibacter michiganense**, WY. On *Datura* sp., *D. innoxia, D. metal, D. meteloides, D. mollis, D. stramonium*.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.
LEAF SPOT; Pod Blight. **Alternaria crassa**, FL, WI.
NEMATODE, Root Knot. **Meloidogyne hapla**.
ROT, Root. **Thielaviopsis basicola**, WI.
VIRUS. **Bromegrass Mosaic**, general.
VIRUS. **Tomato Spotted Wilt**, CA, TX; **Potato Leafroll**, Pacific NW.

DAYLILY (*Hemerocallis*)

BLIGHT, Gray Mold. **Botrytis** sp., MD.
BLIGHT, Leaf. **Kabatiella** sp., secondary, MD.
LEAF SPOT. **Cercospora hemerocallis**, IL; **Heterosporium gracilis**, NJ, NY, TX; Leaf Streak, **Gloecephalus hemerocalli**, MS, and **Collecephalus hemerocalli**, LA, MS, PA.
NEMATODE, Root Knot. **Meloidogyne incognita**.
ROT, Root. **Sclerotium** sp., IN; **Phymatotrichum omnivorum**, TX; **Armillaria gallsia**, SC.
RUST. **Puccinia hemerocallidis**, FL, GA, HI, Costa Rica.

DECUMARIA

LEAF SPOT. **Cercospora decumariae**, MS.

DELPHINIUM (Larkspur)

BACTERIAL Black Spot, Leaf Spot. **Pseudomonas syringae** pv. **delphinii**, ME to VA, MN, TX, rare in Pacific Coast states.

BACTERIAL Collar Rot. **Erwinia carotovora**, CA, NY.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, WA.

BACTERIAL Foot Rot; Blackleg. **Erwinia carotovora** pv. **atroseptica**, general.

BACTERIAL, MLO. **California Aster Yellows** Stunt, "Greens", Pacific Coast and Rocky Mts.

BLIGHT, Gray Mold, Bud Rot. **Botrytis cinerea**, CT, MA, MN, MS, NY, WV, WI.

BLIGHT, Southern; Crown Rot. **Sclerotium rolfsii** (*S. delphinii*), general.

CANKER, Stem. **Diaporthe arctii**, MD, NY, NC, OH, PA; **Fusarium** spp., widespread; **F. oxysporum** f. sp. **delphinii**, wilt, NY; **Volutella** sp., MD; **Phoma** sp., CT, NJ, NY.

DAMPING-OFF; Root Rot. **Pythium** spp. and **Rhizoctonia solani**, cosmopolitan.

DOWNEY MILDEW. **Peronospora ficariae**, CA.

GALL, Leaf. **Synchytrium aureum**, IA.

LEAF SPOT. **Ascochyta aquilegiae**, CT; **Cercospora delphinii**, CO, MD; **Ovularia delphinii**, WY; **Phyllosticta** sp., NY; **P. delphinii**, CO; **Ramularia delphinii**, CA, CO, UT; **Septoria delphinella**, IL, KS, WI.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, OR, WA.

NEMATODE, Lesion. **Pratylenchus pratensis**.

NEMATODE, Root Knot. **Meloidogyne** spp., AZ, NJ, NY, VA, WA.

NONPARASITIC. **Chlorosis**. Low temperature and wet soil.

Variegation. Noninfectious, seed transmitted leaf-color anomalies.

POWDERY MILDEW. **Golovinomyces cichoracearum**, MA, MN, NY, WA; **Erysiphe polygoni**, general but some varieties resistant; **Sphaerotheca macularis**, CA.

ROT, Collar; Leaf Spot. **Diplodina delphinii**, CA, NY.

ROT, Crown. **Sclerotium delphinii**. See Blight, Southern.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium aphanidermatum**; **P. ultimum**; **P. vexans**.

ROT, Stem. **Phytophthora** sp., MN; **Sclerotinia sclerotiorum**, widespread.

RUST. **Puccinia delphinii** (III), CA; **P. recondita** (0, I), NE to NM, CA.

SMUT, Leaf and Stem. **Urocystis sorosporioides**, CA, KY, VA.

SMUT, White. **Entyloma winteri**, CA; **E. wyomingense**, WY.
VIRUS. **Delphinium Ring Spot**, CA; **Celery Calico**, CA, ID, WA; **Beet Curly Top**, CA; **Cucumber Mosaic**; **Tomato Spotted Wilt**, CA.
WILT. **Verticillium albo-atrum**, NY, WA.
One of the chief delphinium problems is a condition known as "blacks", which looks like a disease and is often confused with bacterial black spot but is caused by cyclamen mites. Plants are stunted and deformed; buds turn black. The bacterial disease causes black tar spots on leaves but no deformity, no stunting of the whole plant. Crown rot or southern blight is often fatal to delphiniums. When yellowing and wilting appear, check the soil around the crown for reddish sclerotia and white mycelium and take immediate sanitary measures. Many foot, collar, and root rots and stem cankers afflict delphinium. Because of these, many gardeners grow hybrid delphinium as biennials, rotating locations, choosing well-drained sites. Virus diseases are more important along the Pacific Coast. Use virus-free planting stock and rogue out infected individuals.

DEMORPHOTHECA

VIRUS. **Bidens Mottle**, FL.

DESERT BIRD OF PARADISE (*Caesalpinia*)

POWDERY MILDEW. **Leveillula taurica**, AZ.

DESERT-CANDLE (*Eremurus*)

LEAF SPOT. **Myrothecium roridum**, OH.

DESERT-PLUME (*Stanleya*)

LEAF SPOT. **Cercospora nasturtii**, KS.
RUST. **Puccinia aristidae**, CO, NV.

DESERT-ROSE (*Adenium obesum*)

LEAF SPOT. **Aristastoma** sp., FL.
VIRUS. **Tomato Spotted Wilt**, FL; **Cucumber Mosaic**, FL.

DESERT-WILLOW (*Chilopsis*)

DAMPING-0FF. **Pythium ultimum**, NE; **Rhizoctonia solani**, NE, TX.
LEAF SPOT. **Phyllosticta erysiphoides**.
ROT, Root. **Phymatotrichum omnivorum**, TX.

DESMODIUM (Arrowleaf)

VIRUS. **Peanut Mottle**, GA.

DEUTZIA

LEAF SPOT. **Cercospora deutziae**, DE, IA, TX; **Phyllosticta deutziae**, AL, IA, NJ, TX.
NEMATODE, Root Knot. **Meloidogyne** spp.
ROT, Root. **Armillaria mellea**, CA.

DEVILS-CLUB (*Oplopanax*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Cercospora daemonicola**, OR.

DEVILWOOD (*Osmanthus americanus*)

BLACK MILDEW. **Asterina asterophora**, FL, GA; **A. discoidea**; **A. purpurea**, FL; **Lembosia oleae**, MS; **Meliola amphitricha**, FL to MS.
LEAF SPOT. **Phyllosticta oleae**, FL, NC.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL.

DEWBERRY (*Rubus*)

BACTERIAL Cane Gall. **Agrobacterium rubi**, NY, OR.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general.

BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, OR.

BLACK MILDEW. **Irenina sanguinea**, AL, LA.

BLIGHT, Cane; DIEBACK. **Leptosphaeria coniothyrium**, general; **L. thomasiana**, OR, WA.

BLIGHT, Spur. **Didymella applanata**, OR, WA.

BLIGHT, Stamen; Dry Berry. **Hapalosphaeria deformans**, OR, WA.

BLOTCH, Sooty. **Gloeodes pomigena**, NC, PA.

CANKER; Fruit Rot. **Glomerella cingulata**, GA, IL, MD, MS.

CANKER; Cane Spot. **Ascospora ruborum**, AL, CA.

DOWNY MILDEW. **Peronospora rubi**, FL, MD, WI, WA; **P. potentillae**, CT, IL, LA.

FRUIT SPOT; Flyspeck. **Leptothyrium pomi**, NC.

GALL, Yellow Leaf. **Synchytrium aureum**, WI.

LEAF SPOT. **Mycosphaerella confusa**, NJ to FL, IL, TX; **Pezizella oenotherae**, MD to NC; **Phyllosticta ruborum**, NY; **P. dispergens**, IL; **Septoria rubi** (**Mycosphaerella rubi**), general; **S. darrowi**, NY.

POWDERY MILDEW. **Sphaerotheca macularis**, IL, IN, MN, OH, PA, Pacific Northwest.

ROSETTE; Double Blossom. **Cercosporella rubi**, NC to AL, LA, MS, TX, IL.

ROT, Collar. **Rhizoctonia solani**, TX, WA.

ROT, Fruit. **Botrytis cinerea**; **Phyllosticta carpogena**, MD, NJ, NY, NC.

ROT, Root. **Armillaria mellea**, OR; **Collybia dryophila**, NC; **Corticium galactinum**, MD, VA, TX; **Helicobasidium purpureum**, NC, TX; **Phymatotrichum omnivorum**, TX.

RUST. **Gymnoconia peckiana**, orange (0, I, III), ME to VA, CA, MN, MO; **Kuehneola uredinis**, yellow (0, I, II, III), ME to FL, CA, KS, TX, WA; **Kunkelia nitens**, orange (I), CA, OR, CT to FL, IA, TX; **Mainsia rubi** (II, III), TX.

SPOT ANTHRACNOSE. **Elsinoë veneta**, general.

VIRUS. **Raspberry Beta Leaf Curl**, MI, OH, TX; **Raspberry Mosaic**, CT, MI, NJ, NY, Pacific Coast; **Loganberry Dwarf**, especially on loganberry, CA, OR, WA.

WILT. **Verticillium albo-atrum**, CA, OR, WA.
Use virus-free, bacterial-free, planting stock; spray for anthracnose.

DIANTHUS (Garden Pinks)

BLIGHT; Stem Rot. **Alternaria dianthi**, widespread.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, IL, TX.
LEAF, Blight. **Rhizoctonia solani**, LA.
LEAF SPOT. **Ascochyta dianthi**, NY, MS; **Heterosporium echinulatum**, CA, NY, OR; **Septoria dianthi**, AL, MI, MS,NJ, NY, NC.
NEMATODE, Root Knot. **Meloidogyne** sp., AL, MS, TX.
ROT, Bud. **Fusarium poae**, NY.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium ultimum**, CA.
ROT, Stem. **Rhizoctonia solani**, widespread.
RUST. **Puccinia arenariae**, NY; **Uromyces dianthi** (II, III), MS, NE, NY.
VIRUS. **Beet Curly Top**, CA; **Carnation latent**, NY.

DICHONDRA (Lawn-Leaf)

BLIGHT, Southern. **Sclerotium rolfsii**, CA.
GALL, Leaf. **Synchytrium edgertonii**, LA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
RUST. **Puccinia dichondrae** (II, III), LA, MS, NC, TX.
VIRUS. **Cucumber Mosaic**, CA.

DIEFFENBACHIA

ANTHRACNOSE. **Glomerella cincta**, NJ; **Gloeosporium** sp., WA; **Colletotrichum** sp., WA.
BACTERIAL Stem and Leaf Rot. **Erwinia dieffenbachiae**, FL.
LEAF SPOT. **Cephalosporium dieffenbachiae**, FL, NY; **Leptosphaeria** sp., FL; **Myrothecium roridum**, FL.
ROT, Root. **Pythium splendens**, FL; **Rhizoctonia** sp., FL.
ROT, Stem. **Phytophthora palmivora**, CA, FL.
ROT, Stem, Leaf, Cutting. **Fusarium solani**, FL.
Propagate from disease-free canes.

DIERVILLA (Bush Honeysuckle)

LEAF SPOT. **Cercospora weigeliae** (*C. diervillae*) ME, TX; **Phyllosticta diervillae**, WI; **Ramularia diervillae**, ME, NH, NY, WI; **Septoria diervillae**, IA, MA, MN, WI.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Microsphaera alni**, NJ, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Tobacco Ringspot**, MD.

DIGITARIA (Large Crabgrass)

ROT, Root. **Pythium arrhenomanes**, LA.

DILL (*Anethum*)

BACTERIAL, MLO. **Aster Yellows**, NY, TX.
BLIGHT. **Itersonilia perplexans**, CA.
DAMPING-OFF. **Rhizoctonia solani**, GA.
DODDER. **Cuscuta** sp., GA.
LEAF SPOT; Stem Spot. **Cercospora anethi**, ND, OR, TX; **Phoma anethi**, CT, IN, IA.
ROT, Root; Wilt. **Fusarium** sp., OH; **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, TX.

DIODIA

VIRUS. **Diodia Vein Chlorosis**, AR.

DITTANY, STONEMINT (*Cunila*)

LEAF SPOT. **Septoria cunilae**, IL.
RUST. **Puccinia menthae** (0, I, II, III), NY to VA, AR, IL.

DIZYGOTHECA

LEAF SPOT. **Alternaria panax**, CA.

DODDER (*Cuscuta*)

VIRUS. **Tomato Ringspot**, PA.

DODECATHEON (Shooting-Star)

LEAF SPOT. **Heterosporium** sp., AK; **Phyllosticta dodecathei**, TX, WI.
RUST. **Puccinia melanconioides** (0, I, III), CA, OR; **P. ortonii** (0, I, II, III), AK, CA, OR, SD, UT, WA; **P. solheimi** (III) WY; **Uromyces acuminatus** var. **steironematis** (0, I), NE, ND; II, III on marsh grasses.

DOGBANE (*Apocynum*)

LEAF SPOT. **Cercospora apocyni**, north central states, TX, VA; **Phyllosticta apocyni**, IA, MS, NJ, NY, OR, PA,WI; **Septoria littorea**, KS, MI, NE, ND, OH; **Stagonospora apocyni**, IL, IN, IA, NY, WI, VA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia seymouriana** (0, I), IL, IN, KS, NE, NJ, NY, OK, SD; **P. smilacis** (0, I), IL, KS, MD, NC, TN, VA, WI; II, III on smilax.

DOGWOOD, DWARF, BUNCHBERRY (*Cornus canadensis*)

LEAF SPOT. **Ceratobasidium anceps**, rot, NH; **Discohainesia oenotherae**, also stem spot, ME, NH; **Phyllosticta** sp., NY; **Ramularia** sp., NY; **Septoria canadensis**, AK, ME, WA; **Glomerularia corni**, ME to WI, OR.
POWDERY MILDEW. **Phyllactinia corylea**, WA.
RUST. **Puccinia porphyrogenita** (III), ME to AK, WA.

DOGWOOD, FLOWERING (*Cornus florida*)

ANTHRACNOSE. **Colletotrichum gloeosporioides**, TX; **Discula** sp., ID, OR, Pacific NW, MD; **D. destructive**, CT, GA, NC, TN.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MO.
BACTERIAL Leaf Blight. **Pseudomonas syringae**, TN.
BLACK MILDEW. **Dimerosporium pulchrum** and **Meliola nidulans**, Southeast.

BLIGHT, Flower and Leaf. **Botrytis cinerea**, MD, MA, NJ, NY, probably general in wet springs.

BLIGHT, Foliar. **Phytophthora parasitica**, FL; P. sp., TN.

BLIGHT, Thread. **Pellicularia koleroga**, LA.

BLIGHT, Twig, Fruit Spot. **Colletotrichum acutatum**, CT, FL.

CANKER, Crown; Bleeding; Collar Rot. **Phytophthora cactorum**, MD, MA, NJ, NY, WA.

CANKER; DIEBACK. **Botryosphaeria ribis**, PA; **Cytospora** sp., NJ; **Cryptostictis**, NY; **Sphaeropsis** sp.

CANKER, Felt Fungus. **Septobasidium** spp., VA to FL, LA; **Cryptodiaporthe corni** Anamorph, **Myxosporium nitidum**, ND.

DAMPING-OFF. **Colletotrichum acutatum** and **Fusarium oxysporum**, GA.

LEAF SPOT. **Cristulariella pyramidalis**, FL; **Phyllosticta cornicola**, PA to VA, KS, TN; **Ascochyta cornicola**, NC, PA; **Cercospora cornicola**, NC to FL; **Septoria cornicola**, NY to GA, IA; **Colletotrichum gloeosporioides**, NY.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL.

NEMATODE, Dagger. **Xiphinema americanum**.

NEMATODE, Lance. **Hoplolaimus uniformis**, RI.

NEMATODE, Sting. **Belonolaimus longicaudatus**, FL.

NONPARASITIC. **Scorch**. Water deficiency, frequent in Southeast.

POWDERY MILDEW. **Microsphaera alni**, MA to NC, IL, WI; **M. pulchra**, CT, SC; **Phyllactinia corylea**, general.

ROT, Root. **Armillaria mellea**, NY; **Clitocybe tabescens**, FL, GA; **Phymatotrichum omnivorum**, TX; **Corticium galactinum**, VA; **Pythium** sp.

ROT, Wood. **Daedalea confragosa**, MD, NC, PA, TN, VA, WV; **Daldinia vernicosa**, MD; **Lenzites betulina**, NC; **Polyporus** spp.; **Poria** spp., MD, PA.

SPOT ANTHRACNOSE. **Elsinoë corni**, DE, FL, GA, LA, MD, NC, SC, VA.

VIRUS. **Tobacco Ring Spot**, MD. **Witches' Broom Disease**, NJ; **Dogwood Mosaic**, SC.

WILT. **Verticillium** sp., MA.

The most serious dogwood disease in the East is crown or bleeding canker, which attacks trees after transplanting or injury. In a wet season spot anthracnose badly disfigures leaves, twigs, berries. In wet weather Botrytis blight is conspicuous as flowers fade and petals rot onto leaves.

DOGWOOD, PACIFIC (*Cornus nuttalli*)

CANKER, Bleeding; Collar Rot. **Phytophthora cactorum**, WA.
CANKER, Trunk. **Nectria galligena**, OR, WA.
POWDERY MILDEW. **Phyllactinia corylea**, general.
ROT, Root. **Armillaria mellea**, WA; Heart, **Fomes igniarius**, OR.

DOGWOOD, PAGODA, GRAY, RED OSIER, WESTERN OSIER (*Cornus* spp.)

Most of the diseases listed for flowering dogwood occur on these shrub dogwoods.

DOLICHOS (Twinflower, Hyacinth Bean)

ANTHRACNOSE. **Colletotrichum dematium** f. sp. **truncata**, GA.
BLACK MILDEW. **Parodiella perisporioides**, NC.
LEAF SPOT. **Cercospora canescens**, FL.
NEMATODE, Root Knot. **Meloidogyne** spp., FL, SC.
POWDERY MILDEW. **Microsphaera euphorbiae**, IN.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Mosaic**, unidentified, MI.
VIRUS. **Potato Virus X**, Work at Wisconsin on *Dolichos biflorus, D. lablab*.

DORONICUM (Leopards-bane)

NEMATODE, Leaf. **Aphelenchoides** sp.
NEMATODE, Root Knot. **Meloidogyne** sp., CA, MD.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA.

DOUGLAS-FIR (*Pseudotsuga*)

BACTERIAL Gall. **Agrobacterium pseudotsugae**, CA.
BLIGHT, Brown Felt. **Herpotrichia nigra**, Rocky Mts. and Pacific Northwest.
BLIGHT, Gray Mold; Snow Mold. **Botrytis cinerea**, cosmopolitan.
BLIGHT, Needle. **Rosellinia herpotrichioides**, CA.

BLIGHT. **Phoma eupyrena**, CA; **Phytophthora ramorum** (also small branch canker), CA.

BLIGHT, Seedling. **Rhizina undulata**, Pacific Northwest; **Fusarium oxysporum**, OR.

BLIGHT, Seedling Smother. **Thelephora terrestris**, Pacific Northwest.

BLIGHT, Snow. **Phacidium infestans**, ID.

CANKER, Bark. **Brunchorstia** (*Cryptosporium*) **boycei**, WA; **Chondropodium pseudotsugae**, OR; **Aleurodiscus** spp., weakly parasitic.

CANKER, Branch. **Dermea pseudotsugae**, CA.

CANKER, Branch, Trunk. **Dasyscyphus pseudotsugae**; **D. ellisiana**, twig, MA, NC, RI; **Phomopsis lokoyae**, Pacific Coast; **Cytospora** sp., twig, CO, NJ, OR; **Phaciopycnis** (*Phomopsis*) **pseudotsugae**; **Phomopsis lokoyae**, CA.

CANKER; DIEBACK. Collar Rot; Seedling Blight. **Diplodia pinea**, CA, KS, NJ, NY.

DAMPING-OFF. **Rhizoctonia solani**, cosmopolitan.

MISTLETOE; Witches Broom. **Arceuthobium douglasii**, MT to CO, OR, WA. **Phoradendron serotinum** (**flavescens**), TX.

NEEDLE CAST. **Adelopus gaeumannii**, Pacific states, Northeast; **Rhabdocline pseudotsugae**, general; **R. pseudotsugae** subsp. **pseudotsugae**, PA; **R. weirii**, PA; **Rhabdogloeum hydrophyllum**, AZ, NM.

NEEDLE CAST, Swiss. **Phaeocryptopus gaeumannii**, general, MN (also Lake states).

NEEDLE, Flyspeck. **Leptothyrium pseudotsugae**, CO.

NEMATODE, Ring. **Criconemoides crotaloides**; **Meloidodera** sp., OR.

ROT, Root. **Armillaria mellea**, cosmospolitan; **Sparassis radicata**, Pacific Northwest; **Phytophthora cinnamomi**, OR, WA, Southeast; **Phymatotrichum omnivorum**, TX; **Verticicladiella wagenerii**, CA, MT.

ROT, Root. **Armillaria mellea**, PA; **Fusarium solani**, PA; **F. oxysporum**, PA; **F. avenaceum**, PA.

ROT, Stem, Seedling. **Fusarium avenaceum**, OR; **sambucinum**, OR.

ROT, White Pocket. **Ganoderma oregonensis**, MT, OR, WA; **Hydnum coralloides**, Pacific Northwest.

ROT, Heart, Wood. **Poria weirii**, destructive, OR, WA; **Echinodontium tinctorium**; **Fomes** spp.; **Polyporus** spp.; **Lenzites saepiaria**, widespread; **Stereum** spp.; **Trametes** spp.

RUST. **Melampsora albertensis** (0, I), MT to CO, UT, WA; II, III on poplar.

RUST, Leaf. **Melampsora medusae** f. sp. **deltoidae** (O, I), WA; II, III on poplar.

DRABA (Whitlow-Grass)

DOWNY MILDEW. **Peronospora parasitica**, CO, IL, IA, KS, NE, SD, TX, WI.

RUST. **Puccinia aristidae** (0, I), AZ; **P. drabae** (III), AK, UT, WY; **P. holboellii** (0, III), CA, CO, UT; **P. monoica** (0, I), CA, NM.

WHITE RUST. **Albugo candida**, KS, WY.

DRACAENA

ANTHRACNOSE. **Colletotrichum** sp., **Gloeosporium** sp., WA.

BACTERIAL, Leaf Spot. **Erwinia herbicola**, FL; **E. carotovora** pv. **carotovora**, FL.

BLIGHT, Tip. **Physalospora dracaenae**, WV; **P. rhodina**, MD.

LEAF SPOT; Tip Blight. **Glomerella cincta** (*Colletotrichum dracaenae*), general; **Phyllosticta dracaenae**, FL, NJ; **P. draconis**; **P. maculicola**; **Gloeosporium polymorphum** and **G. thuemenii**, widespread; **Lophodermium dracaenae**, black spot, CA.

NEMATODE, Lance. **Hoplolaimus bradys**, FL.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

NEMATODE, Sheath. **Hemicycliophora parvana**.

ROT, Stem. **Aspergillus niger** var. **floridanus**, FL.

VIRUS. **Tomato Spotted Wilt**, PA.

DRAGONHEAD (*Dracocephalum*)

DOWNY MILDEW. **Peronospora** sp., WI, WY.

BLIGHT, Southern. **Sclerotium rolfsii**, IL, TX.

LEAF SPOT. **Phyllosticta dracocephali**, TX; **Septoria dracocephali**, TX, WI.

DURANTA

BLIGHT, Seedling. **Sclerotium rolfsii**, FL.

LEAF SPOT, Black. **Phyllachora fusicarpa**, FL.

DUTCHMANS-BREECHES, SQUIRREL-CORN (*Dicentra*)

DOWNY MILDEW. **Peronspora dicentrae**, IN, MD, MI, MO, NY, VA, WI.
RUST. **Cerotelium dicentrae** (0, I), NY to MD, KS, SD; II, III on wood-nettle.

DUTCHMANS-PIPE (*Aristolochia*)

BLIGHT, Gray Mold. **Botrytis cinerea**, CT, MD.
LEAF SPOT. **Cercospora guttulata**, IL, WV; **Gloeosporium** sp., MA; **Ovularia aristolochiae**, WV; **Phyllosticta aristolochiae**, NJ.
ROT, Root. **Diplodia radicicola**, VA.

DYSCHORISTE

RUST. **Aecidium tracyanum** (0, I), FL.

EASTER CACTUS (*Rhipsalidopsis*)

ROT, Stem. **Drechslera cactivora** (*Helminthosporium cactivorum*), FL.

ECHEVERIA

LEAF SPOT. **Stemphylium bolickii**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
RUST. **Puccinia echeveriae** (III), CA.

ECHINACEA (Purple coneflower)

BACTERIAL, phytoplasma. **Aster Yellows**, WI.
BLIGHT, Wilt. **Fusarium oxysporum**, SD.
LEAF SPOT. **Cercospora rudbeckii**, IA; **Septoria lepachydis**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, Canada.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**.
VIRUS. **Mosaic**, unidentified, NY.
WILT. **Verticillium dahliae**, OR.

ECHINOCHLOA (Barnyardgrass)

ROT, Root. **Pythium arrhenomanes**, LA.

ECLIPTA

BLIGHT. **Sclerotinia minor**, OK.

EGGPLANT (*Solanum melongena*)

ANTHRACNOSE. **Colletotrichum** spp.; **Gloeosporium melongenae**, NJ to FL, IA, TX; **Glomerella cingulata**, IA.

BACTERIAL Canker. **Clavibacter michiganense**, WY.

BACTERIAL Soft Rot. **Erwinia carotovora**, NJ.

BACTERIAL Wildfire. **Pseudomonas syringae** pv. **tabaci**.

BACTERIAL Wilt. **Pseudomonas solanacearum**, general.

BLIGHT, Early. **Alternaria solani**, occasional, NY to FL, LA, WI.

BLIGHT, Late. **Phytophthora infestans**, FL, NY.

BLIGHT, Phomopsis; Fruit Rot. **Phomopsis vexans**, general.

BLIGHT, Southern. **Sclerotium rolfsii**, VA to FL, LA, WI.

DAMPING-OFF. **Pythium debaryanum**, CT, LA, NY; **Rhizoctonia solani**, also stem and fruit rot, general.

DODDER. **Cuscuta** spp., KS, NJ, PA, VA.

DOWNY MILDEW. **Peronospora tabacina**, SC.

FRUIT SPOT. **Diplodia natalensis**, FL; **Lasiodiplodia theobromae**, GA.

LEAF SPOT. **Ascochyta lycopersici**, DE, IL, IN, NY; **Cercospora melongenae**, CA; **Phyllosticta solani**, LA; **P. hortorum**, LA, NJ; **Septoria lycopersici**, IN, MD, NC, VA; **Stemphylium solani**, FL.

NEMATODE, Golden. **Globodera rostochiensis** (formerly, **Heterodera rostochiensis**).

NEMATODE, Lesion. **Pratylenchus pratensis**, TX.

NEMATODE, Root Knot. **Meloidogyne hapla**; **M. incognita**; **M. javanica**.

NEMATODE, Tobacco Cyst. **Heterodera tabacum**, VA.

POWDERY MILDEW. **Golovinomyces cichoracearum**, NJ, VA.

ROT, Charcoal. **Macrophomina phaseoli**, NJ.

ROT, Cottony Leak. **Pythium aphanidermatum**, CA, FL, TN.

ROT, Fruit. **Colletotrichum truncatum**, MS; **Phytophthora parasitica**, FL, IN; **Rhizopus stolonifer**, CA, IN, TX.

ROT, Gray Mold. **Botrytis cinerea**, CA, CT, MA, NJ, VA, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia substriata (I)**, AL, FL, GA, IA, TX.
VIRUS. **Eggplant Mosaic**; **Cucumber Mosaic**; **Beet Curly Top**, OR, TX, WA, **Tomato Spotted Wilt**.
WILT. **Fusarium** sp.; **Verticillium albo-atrum**, general.
Phomopsis blight and Verticillium wilt are the two most important eggplant diseases. Choose varieties resistant to blight and for wilt plant a long rotation, which does not include tomatoes, potatoes, or raspberries.

ELAEAGNUS (Russian-Olive, Silverberry)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, GA; Hairy Root, **A. rhizogenes**, IA.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
BLIGHT, Stem and Branch, Bark and Cambium Necrosis. **Botryodiplodia theobromae**, ND, SD, Southern Plains, NE, Great Plain states.
BLIGHT, Thread. **Rhizoctonia ramicola**, FL.
BLIGHT, Tip. **Gloeosporium fructigenum**.
CANKER. **Nectria cinnabarina**, CA; **Fusarium** sp., WY; **Phytophthora cactorum**, AZ, IL; **Fusicoccum elaeagni**, IL; **Tubercularia ulmea**, ND, SD.
CANKER, Phomopsis. **Phomopsis elaeagni**, (*Fusicoccum elaeagni*) DE, OH; **P. arnoldia** (syn. *P. elaeagni*), MI, ND, SD.
LEAF SPOT. **Cercospora carii**, TX; **C. elaeagni**, FL, MS, OK, TX; **Phyllosticta argyrea**, MD, NC; **Septoria argyrea**, IA, NE, ND, WI; **S. elaeagni**, KS.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL.
POWDERY MILDEW. **Phyllactinia corylea**, OR; **P. elaeagni**, WY.
ROT, Root. **Clitocybe tabescens**, FL.
RUST. **Puccinia caricis-shepherdiae** (0, I), Northern Plains; II, III on *Carex*; **P. coronata** (0, I), MT, ND; II, III on *Calamagrostis*.
WILT. **Verticillium** sp., WA.

ELDER (*Sambucus*)

BLIGHT, Thread. **Pellicularia koleroga**, LA; Web, **P. filamentosa**, FL.
CANKER, Branch. **Cytospora sambucicola**, IL; **C. chrysosperma**.

CANKER; DIEBACK. **Botryosphaeria ribis**, FL, GA; **Diplodia** spp.; **Nectria cinnabarina**, widespread; **N. coccinea**, MD, MI, WA; **Sphaeropsis sambucina**.

GALL, Leaf. **Synchytrium sambuci**, LA.

LEAF SPOT. **Ascochyta sambucina**, AK; **A. wisconsina**, NY, WI; **Cercospora catenospora**, AL, KS, MS; **C. depazeoides**, general; **Cercosporella prolificans**, CA, NM, OR; **Gloeosporium tineum**, MS, TX; **Phyllosticta sambuci**, MO, NY, WI; **Ramularia sambucina**, MO, NY, WI, WA; **Mycosphaerella** sp., NM; **Septoria sambucina**, VT to FL, CA, OR, TX, WA.

POWDERY MILDEW. **Microsphaera alni** and **M. grossulariae**, general; **Phyllactinia corylea**, MI; **Sphaerotheca macularis**, MA.

ROT, Heart, Wood. **Fomes igniarius**, ID; **Hymenochaete agglutinans**, WY; **Polyporus** spp.

ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX; **Xylaria multiplex**, TX.

RUST. **Puccinia bolleyana** (0, I), ME to FL, MN, TX; II, III on *Carex*.

SPOT ANTHRACNOSE. **Sphaceloma** sp., LA.

VIRUS. **Tobacco Mosaic**.

WILT. **Verticillium albo-atrum**, MD.

ELDERBERRY

VIRUS. **Tobacco Ring Spot**.

ELEPHANTS-EAR (*Colocasia*)

BACTERIAL Soft Rot. **Erwinia carotovora**, FL; **E. aroideae**, FL, TX.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, NY.

LEAF SPOT. **Cladosporium colocasiae**, LA.

NEMATODE, Root Knot. **Meloidogyne** sp., FL, TX.

ROT, Black, of tuber. **Diplodia** sp., FL, SC, TX; Gray, **Fusarium solani**, FL, TX.

ROT, Root. **Pythium debaryanum**, CA.

VIRUS. **Dasheen Mosaic**, HI.

ELEUSINE (Goosegrass)

ROT, Root. **Pythium arrhenomanes**, LA.

ELM (*Ulmus*)

BACTERIAL, Leaf Scorch. **Xylella fastidiosa**, OK.

BACTERIAL, Leaf Spot. **Pseudomonas syringae**, PA.

BACTERIAL, MLO. **Phloem Necrosis**, AL, AR, GA, IL, IN, IA, KS, KY, MS, MO, NE, NJ, NY, OH, OK, PA, TN, WV.

BACTERIAL Wetwood. **Erwinia nimipressuralis**, VA, on Siberian elm (*Ulmus pumila*).

BACTERIAL Wetwood; Slime Flux. **Erwinia nimipressuralis**.

BLIGHT, Twig. **Septogloeum parasiticum**, MI; **Phomopsis oblonga**, MA; **Fusarium** spp.

BLIGHT, Twig. **Phomopsis oblonga**, VA, on Chinese elm (*Ulmus parvifolia*).

CANKER, Bleeding. **Phytophthora cactorum**, RI; Pit, **P. inflata**, CT, MA, NY, PA.

CANKER, Felt Fungus. **Septobasidium pseudopedicellatum**, NC.

CANKER, Stem. **Botryosphaeria ribis**.

CANKER, Twig. **Sphaeropsis ulmicola**, VA, on Chinese elm (*Ulmus parvifolia*).

CANKER, Twig Dieback. **Apioporthe apiospora**, IA; **Coniothyrium** spp., IL, MA, MI; **Cytospora ludibunda**, CT, PA; **Nectria coccinea**, NJ, NY; **N. cinnabarina**, coral spot, widespread; **Phoma** sp., **Phomopsis** sp., Northeast to IL, MN, SC; **Sphaeropsis** sp., CT to MS; **Cytosporina ludibunda**, IL, KS.

DAMPING-OFF. **Rhizoctonia solani**, cosmopolitan; **Pythium** sp.

DIEBACK. **Cephalosporium** sp., VA, on English Elm (*Ulmus procera*).

LEAF BLISTER. **Taphrina ulmi**, CT to MS, MO, WI.

LEAF SPOT. **Cercospora sphaeriaeformis**, LA, TX; **Cylindrosporium tenuisporium**, TX; **Coryneum tumoricola**, NY; **Gloeosporium ulmicola**; **Monochaetia desmazierii**, GA; **Phyllosticta confertissima**, PA; **Mycosphaerella ulmi**, MA to AL; **Septogloeum profusum**, AL; **Coniothyrium ulmea**, WV; **Ceratophorum ulmicola**, KS, NE.

LEAF SPOT; Anthracnose. **Gloeosporium inconspicuum**, MA to VA; MN, OK.

LEAF SPOT; Black Spot. **Gnomonia ulmea**, general.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), IN, TX; **P. tomentosum**, TX.

MISTLETOE, European. **Viscum album**, CA.
NEMATODE, Dagger. **Xiphinema americanum**.
NEMATODE, Root Knot. **Meloidogyne** spp.
NEMATODE, Stem. **Ditylenchus gallicus**; Leaf, **Aphelenchoides fragariae**.
PHYTOPLASMA. **Elm Yellows**, NY.
POWDERY MILDEW. **Microsphaera alni**, IL, IA, MS, OH; **Phyllactinia corylea**, NC to TX, IA; **P. ungulata**, GA; **Uncinula macrospora**, general.
ROT, Heart. **Collybia velutipes**, widespread; **Daedalea confragosa**, widespread; **Fomes** spp.; **Ganoderma curtisii**, NY.
ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX; **Xylaria** spp.; **Armillaria mellea**, MO; **Clitocybe tabescens**, FL.
ROT, Wood. **Daldinia concentrica**, widespread; **Lenzites betulinum**, IN, MA, MD; **Pleurotus ostreatus**, widespread; **Polyporus** spp.; **Schizophyllum commune**, cosmopolitan; **Ustulina vulgaris**, MD.
WILT. **Dothiorella** (*Cephalosporium*) **ulmi**, general; **Verticillium albo-atrum**, ME to VA, MS, OR, WI.
WILT; Dutch Elm Disease. **Ceratocystis ulmi**, general.
The Dutch elm disease and phloem necrosis have taken a heavy toll of elms in many states. A dormant spray for the bark beetles that spread Dutch elm disease is the present recommendation, combined with general sanitation. Chemotherapy is still promising but not yet practical. Some seedling elms are highly resistant but not immune.

EMILIA (Tasselflower, Floras-Paintbrush)

RUST. **Puccinia emiliae**, FL.
VIRUS. **Cucumber Mosaic**, in part, FL; **Tomato Spotted Wilt**, CA; **Impations Necrotic Spot**, GA.

ENCELIA

NEMATODE, Root Knot. **Meloidogyne** sp., CA.
RUST. **Puccinia enceliae** (0, I, III), CA.

ENDIVE, ESCAROLE, WITLOOF CHICORY (*Cichorium*)

BACTERIAL, Apical Rot. **Pseudomonas cichorii**, CA.

BACTERIAL Center Rot. **Pseudomonas cichorii** and **P. intybus**, AZ, CA, FL, MT, TX, WA.

BACTERIAL, Leaf Spot. **Pseudomonas cichorii**, FL; **P. syringae**, CA.

BACTERIAL, MLO. **Aster Yellows** and **California Aster Yellows**.

BACTERIAL Soft Rot. **Erwinia carotovora**, MA, NY.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, TX.

DAMPING-OFF; Bottom Rot, Leaf Blight. **Rhizoctonia solani**, CA, CT, FL, NY, TX.

DOWNY MILDEW. **Bremia lactucae**, FL, PA.

LEAF SPOT. **Alternaria** sp., CA, CT, FL, NY; **Cercospora cichorii**, TX; **Marssonina panattoniana**, TX; **Ramularia cichorii**, NY.

NEMATODE, Root Knot. **Meloidogyne** sp., MA, NJ, TN.

NEMATODE, Sting. **Belonolaimus gracilis**.

NONPARASITIC. **Brown Heart**. Boron deficiency, in part, NJ, NY.
Tipburn. High temperature and excessive transpiration.

POWDERY MILDEW. **Golovinomyces cichoracearum**, ID, NJ, CA.

ROT, Crown Wilt. **Sclerotinia minor**, CA.

ROT, Gray Mold. **Botrytis cinerea**, CA, FL, NY, PA.

ROT, Root. **Pythium debaryanum**, CT, FL, NY, PA; **Phymatotrichum omnivorum**, AZ.

ROT, Watery Soft. **Sclerotinia sclerotiorum**, AZ, AR, CA, FL, LA, MT, PA, TX.

RUST. **Puccinia hieracii** (0, I, II, III), CA, CT, MA, NY.

SLIME MOLD. **Fuligo septica**, NJ.

VIRUS. **Mosaic**, unidentified, FL; **Tomato Spotted Wilt**; **Tomato Ringspot**, VT; **Tobacco Streak**, FL.

ENGELMANNIA (Engelmann Daisy)

BROOMRAPE. **Orobanche ramosa**, TX.

GALL, Leaf. **Synchytrium taraxaci**, TX.

ENGLISH DAISY (*Bellis perennis*)

BACTERIAL, MLO. **Aster Yellows**, NJ, NY.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Cercospora** sp., MN.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Crown. **Sclerotinia sclerotiorum**, NJ.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium mastophorum**, MD.
RUST. **Puccinia lagenophorae**, CA.
VIRUS. **Tomato Spotted Wilt**, PA.

EPIGAEA (Mayflower, Trailing Arbutus)

LEAF SPOT. **Cercospora epigaeae**, NY, NC, WI; **Phyllosticta epigaeae**, MA, NY.
POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, CT to VA, WI.

EPILOBIUM (Willow-Herb, Fireweed)

BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
DOWNY MILDEW. **Plasmopara epilobii**, AK, IL, NY.
LEAF SPOT. **Cercospora montana**, widespread; **Discosia bubaki**, NY, WI; **Phyllosticta chamaeneri**, OR; **P. wyomingensis**, WY; **Ramularia cercosporoides**, AK, MT, TX, WA, WY; **Septoria epilobii**, CA, DE, IL, VT, WI.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Sphaerotheca macularis**, widespread; **Erysiphe polygoni**, WA; **Microsphaera** sp., IL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia epilobii** (III), MI, WY; **P. dioicae** (0, I), CO; **P. gigantea** (III), ID, MT, TX, WA, WY; **P. scandica** (III), UT, WA, WY; **P. oenotherae** (0, I, II, III), CA; **P. pulverulenta** (0, I, II, III), ND to NM, CA; **P. veratri** (0, I), NH, MT to WA; **Pucciniastrum pustulatum** (II, III) widespread; 0, I on fir.
SMUT, Leaf. **Doassansia epilobii**, CO, NH.

EPISCIA

LEAF SPOT. **Myrothecium roridum**, FL.
VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

ERANTHEMUM

LEAF SPOT. **Phyllosticta** sp., NJ.

ERIGERON (Fleabane)

BACTERIAL, MLO. **Aster Yellows**, KS, MD, MS, NJ, NY, OK.
BROOMRAPE. **Orobanche ramosa**, TX.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
DOWNY MILDEW. **Basidiophora entospora**, AL, IL; **Plasmopara halstedii**, IA, MD.
GALL, Leaf. **Synchytrium erigerontis**, LA.
LEAF SPOT. **Cercospora cana**, LA; **Cercosporella colubrina**, WA; **Septoria erigerontis**, ME to MD, MI, NE.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CO, MI, MT, NM, PA, SD, WY; **Phyllactinia corylea**, WA; **Sphaerotheca macularis**, IN, KY.
ROT, Stem. **Sclerotium rolfsii**, IL.
RUST. **Puccinia cyperi** (0, I), MO; II, III on sedge; **P. dioicae** (0, I), East, South; **P. grindeliae** (III), CO, NV, UT, WY; **P. stipae** (0, I), CO, WY; **Coleosporium asterum** (II, III), CA, AK; 0, I on pine.
SMUT, White. **Entyloma compositarum**, MI, ND, UT, WA, WI, WY.
VIRUS. **Mosaic**, unidentified, IN.
WILT. **Verticillium albo-atrum**, MA.

ERIOPHYLLUM

NEMATODE. **Meloidogyne** sp., CA.
RUST. **Puccinia eriophylii** (II, III), WY, OR to CA; **Uromyces junci** (0, I), CA; II, III on *Juncus*.

ERYNGIUM (Rattlesnake Master)

LEAF SPOT. **Cylindrosporium eryngii**, IA, KS, TX, WI; **Septoria eryngicola**, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Macrophomina phaseoli**, OK.
SMUT, White. **Entyloma eryngii**, IA.
VIRUS. **Cucumber Mosaic**, OH.

ERYTHRINA

BLIGHT, Thread. **Pellicularia koleroga**, FL; **Rhizoctonia ramicola**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
WILT. **Verticillium albo-atrum**, CA.

ERYTHRONIUM (Dogs-Tooth Violet, Adders-Tongue, Trout-Lily)

BLIGHT. **Botrytis** sp., IL, NY, VT, WA; **B. elliptica**, WA; **Ciborinia gracilis**, IL, NE; **C. erythronii**, NY.
LEAF SPOT; Black Spot. **Asteroma tenerrimum** var. **erythronii**, ID, MT, WA.
RUST. **Uromyces heterodermus** (0, III), CA, CO, ID, MT, OR, TX, UT, WA, WY.
SMUT. **Ustilago heufleri**, DE, MD, MI, MO, NJ, NY, PA; **Urocystis erythronii**, CT, NY.

ERYTHROXYLUM

WILT. **Fusarium oxysporum** f. sp. **erythroxyli**, HI.

EUCALYPTUS (Gum-Tree)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA.
BLIGHT, Seedling. **Fusarium oxysporum** f. sp. **aurantiacum**, CA.
CANKER. **Diaporthe cubensis**, FL, HI, PR.
CANKER; DIEBACK, Seed Capsule Abortion. **Botryosphaeria ribis**, FL.

CANKER, Felt Fungus. **Septobasidium curtisii**, NC.
LEAF SPOT. **Actinopelte dryina**, LA; **Mycosphaerella molleriana**, CA; **Phyllosticta extensa**, CA.
NONPARASITIC. **Chlorosis**. Iron deficiency, CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, AZ.
ROT, Heart; Wood. **Ganoderma applanatum**; **Polyporus** spp.; **Stereum hirsutum**.
ROT, Root. **Clitocybe tabescens**, FL; **Armillaria mellea**, CA; **Phymatotrichum omnivorum**, TX.
Many other fungi may be found on leaves, twigs, and branches but are not reported as causing specific diseases.

EUCHARIS (Amazon-Lily)

BLIGHT, Gray Mold. **Botrytis cinerea**, FL.
LEAF SCORCH; Red Blotch. **Stagonospora curtisii**, CA.
VIRUS. **Tomato Spotted Wilt**, PA.

EUGENIA

BLACK MILDEW. **Asterinella puiggarii**, FL.
LEAF SPOT. **Pezizella oenotherae**, NY.
ROT, Root. **Clitocybe tabescens**, FL.

EUONYMUS (Burning-Bush, Spindle-Tree)

ANTHRACNOSE. **Colletotrichum griseum**, AL, NJ, NY, GA to TX, AR; **Gloeosporium frigidum**, AR, MS.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, MI, MS, NJ, SC, TX.
BLIGHT, Thread. **Pellicularia koleroga**, LA.
DIEBACK, CANKER, Basal. **Whetzelinia sclerotiorum** (*Sclerotinia*), RI.
LEAF SPOT. **Cercospora destructiva**, VA to TX; **C. euonymi**, PA to WI; **Exosporium concentricum**, AL, MS, SC, TX, VA; **Phyllosticta euonymi**, NY to MS and TX; **P. pallens**, AL; **Septoria euonymi**, MS, VA; **S. atropurpurea**, IL; **Ramularia euonymi**, CA, IA, KS, MO; **Marssonina thomasiana**, OH to WI, MO; **Myocentrospora** sp., OH.

NEMATODE, Root Knot. **Meloidogyne** sp., MD, TX.
POWDERY MILDEW. **Microsphaera alni**, NJ to SD and southward; **Oidium euonymi-japonici**, AL, CA, IA, LA, MS, NJ, SC, TX, WA.
ROT, Crown. **Phytophthora cactorum**.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Fusarium scirpi**, NJ.
VIRUS. **Euonymus Mosaic**; Infectious Variegation, MA.
The Oidium mildew is prevalent throughout the South and in California. Crown gall is common, with conspicuous knobs along the vines, but seldom fatal.

EUPATORIUM (Boneset, Blue Mist-flower, Dogfennel, White Snakeroot, Joe-Pye Weed)

BLIGHT, Gray Mold; Canker. **Botrytis cinerea**, NJ.
DOWNY MILDEW. **Plasmopara halstedii**, NY to MD, KS, MO, TX, WV, WI.
LEAF SPOT. **Ascochyta compositarum**, WV, WI; **Cercospora ageratoides**, AL, MS, NJ, TX, WV; **Phyllosticta decidua**; **P. eupatorina**, IL, NJ; **Septoria eupatorii**, IL, MD, MS, NJ, TX; **S. eupatoriicola**, IL.
NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL; **M. hapla**.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general in East to TX, MN.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotium rolfsii**, CT, IL, MD, NJ, TX; **Rhizoctonia solani**, NJ.
RUST. **Puccinia conoclinii** (II, III) MD to AL, IL, TX; **P. eleocharidis** (0, I), widespread in eastern and central states; II, III on *Eleocharis*; **P. tenuis** (0, I, III), MA to NC, MN, NE; **P. tolimensis** (III), NY.
SMUT, White. **Entyloma compositarum**, IL, IA, MS, WV, WI.
VIRUS. **Yellows**. Apparently distinct from Aster Yellows, central states; Tomato Spotted Wilt, GA.
WILT. **Fusarium** sp., NJ.

EUPHORBIA TRIGONA

ROT, Soft. **Rhizopus stolonifer**, CA.

EURYOPS

POWDERY MILDEW. **Podosphaera** (Shaerotheca) **jusca**, CA.

EUSTOMA (Prairie Gentian, Texas Bluebell)

BLIGHT, Stem. **Alternaria** sp., TX; **Sclerophoma eustomonis**, TX; **Phomopsis** sp., FL.

LEAF SPOT. **Cercospora eustomae**, CO, NE, TX; **C. nepheloides**, CA, TX; **Phyllosticta** sp., TX.

ROT, Crown. **Fusarium avenaceum**, CA; **Sclerotinia rolfsii**, FL.

VIRUS. **Cucumber Mosaic**, NY; **Impatiens Necrotic Spot**, FL; **Tomato Spotted Wilt**, PA; **Tomato Spotted Wilt – Impatiens Serotype**, FL, GA.

EVOLVULUS

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia lithospermi** (0, I, II, III), CO, KS, NE, TX.

VIRUS. **Tobacco Streak**, WI.

EVERLASTING (*Antennaria*)

LEAF SPOT. **Phoma antennariae**, CO; **Phyllosticta antennariae**, DE, WI; **Septoria lanaria**, NY.

ROT, Stem. **Nectria haematococca**, CA.

WHITE RUST. **Albugo tragopogonis**, IL, NE.

WILT. **Nectria haematococca**, CA.

EXACUM

BLIGHT, Stem Canker. **Botrytis cinerea**, KS.

VIRUS. **Impatiens Necrotic Spot**, NC.

WILT. **Fusarium oxysporum** f. sp. **exaii**, CT.

FARKLEBERRY, TREE-HUCKLEBERRY (*Vaccinium arboreum*)

CANKER, Felt Fungus. **Septobasidium sinuosum**, FL.
GALL, Leaf. **Exobasidium vaccinii**, AL, FL.
LEAF SPOT. **Cylindrosporium** sp., TX; **Ophiodothella vaccinii**, MD to GA, TX; **Pestalotia vaccinicola**, secondary, FL; **Phyllosticta vaccinii**, AL, FL, MS, TX; **Septoria albopunctata**, FL, SC, TX; Tar Spot, **Rhytisma vaccinii**, FL, OK, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

FEIJOA (*Pineapple Guava*)

BLIGHT, Thread. **Rhizoctonia ramicola**, FL.
ROT, Fruit. **Botrytis cinerea**, CA; **Colletotrichum gloeosporioides**, CA; **Penicillium expansum**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
SPOT ANTHRACNOSE. **Sphaceloma psidii**, FL.

FENDLERA

RUST. **Gymnosporangium speciosum** (0, I), CO and UT to NM, AZ; II, III on juniper.

FENNEL (*Foeniculum*)

BACTERIAL Leaf Spot. **Pseudomonas syringae**, CA.
BACTERIAL Soft Rot. **Erwinia carotovora**, IL.
BLIGHT, Stem, Foliage. **Cercosporidium punctum**, CA.
DAMPING-OFF; Stem Pitting. **Rhizoctonia solani**, GA, NJ.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Stem. **Sclerotinia sclerotiorum**, IL, NJ, TX; **Sclerotinia minor**, CA.

FENUGREEK (*Trigonella*)

BACTERIAL, Leaf Spot. **Pseudomonas syringae** pv. **syringae**, NJ.

FERN, ADDERS-TONGUE (*Ophioglossum*)

BLIGHT, Leaf. **Curvularia crepini**, OH.

FERN, AQUATIC (*Salvinia* spp.)

LEAF SPOT, Water-Soaked Lesions. **Rhizoctonia solani**, FL.

FERN, BIRDS-NEST (*Asplenium*)

BACTERIAL Leaf Spot. **Pseudomonas asplenii**, CA.
BACTERIAL, Leaf Spot, Blights. **Pseudomonas gladioli**, FL.
LEAF SPOT. **Cercospora** sp., CA.
NEMATODE, Leaf. **Aphelenchoides fragariae**, CT, FL, NJ, NY, PA.
VIRUS. **Tomato Spotted Wilt**, PA.

FERN, BLADDER (*Cystopteris*)

LEAF BLISTER. **Taphrina cystopteridis**, IN, KS, WI.
RUST. **Hyalopsora polypodii** (II, III), general in North and West; **Uredinopsis ceratophora** (II, III), IN, NY, WI; **U. glabra** (II, III), NM.

FERN, BOSTON (*Nephrolepis*)

ANTHRACNOSE; Tip Blight. **Glomerella nephrolepidis**, NY, OH.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
DAMPING-OFF. **Rhizoctonia solani**, FL.
LEAF SPOT. **Cercospora** sp., IN; **Cylindrocladium pteridis**, FL; **Phyllosticta** sp., NY.
RUST. **Desmella superficialis**, FL.

FERN, BRACKEN (*Pteridium*)

LEAF SPOT; Tar Spot; Black Mildew. **Phyllachora** (*Catacauma*) **flabellum**, GA, MD, NJ, PA, SC, TN, WV, WI; **Cryptomycina pteridis**, also leaf roll, widespread, reported under various conidial names; **Phyllosticta pteridis**, ME, NJ.

ROT, Canker. **Rhizoctonia** sp., including **Sclerotium deciduum**, OR, WI.
RUST. **Uredinopsis aspera** (II, III), CA; **U. macrosperma** (II, III), AL, CA, FL, GA, ID, MS, MT, NM, OR, WA, WI; **U. virginiana** (II, III), NY to NC and TN, GA to TX.

FERN, BRAKE (*Pteris*)

BLIGHT, Tip. **Phyllosticta pteridis**, MS, NJ.
DAMPING-OFF. **Completoria complens**, NY; **Pythium intermedium**, NY; **Trichothecium roseum**, IN.
NEMATODE, Leaf. **Aphelenchoides fragariae**, CT, NJ, NY.

FERN, CHRISTMAS (*Polystichum*)

LEAF BLISTER. **Taphrina faulliana**, OR; **T. polystichi**, ME to NC, TN.
LEAF SPOT. **Cylindrocladium pteridis**, FL; Tar Spot, **Trabutiella filicina**, AK.
NEMATODE, Leaf. **Ditylenchus dipsaci**, OR; **Aphelenchoides fragariae**, OR, SC; Lesion, **Pratylenchus penetrans**, FL.
ROT, Root. **Phytophthora cinnamomi**, CA
RUST. **Milesia polystichi** (II, III), ID, MT, OR, WA; **M. vogesiaca** (II, III), OR.

FERN, CLIFF-BRAKE (*Pellaea*)

RUST. **Hyalopsora cheilanthis** (II, III), CA, TX.

FERN, HOLLY (*Cyrtomium*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
DAMPING-OFF. **Completoria complens**, NY.

FERN, JAPANESE CLIMBING (*Lygodium japonicum*) Also – OLD WORLD CLIMBING (*Lygodium microphyllum*)

BLIGHT. **Colletotrichum gloeosporioides**, FL.
LEAF SPOT. **Biopolairs sacchari**, FL.
RUST. **Puccinia lygodii** (on Old World Climbing Fern), FL.

FERN, LADY, SILVERY SPLEENWORT (*Athyrium*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Septoria asplenii**, MI.
RUST. **Uredinopsis copelandii** (II, III), CA; **U. longimucronata** (II, III), ME to PA, WI; 0, I on balsam fir; **U. longimucronata** f. sp. **cyclosora**, AK, CA, ID, MT, OR, WA; 0, I on alpine fir; **U. longimucronata** f. sp. **acrostichoides** (II, III), NH, NY, WI.

FERN, LEATHERLEAF (*Rumohra*)

ROT, Postharvest. **Rhizoctonia** sp., FL; **Cylindrocladium pteridis**, FL; **C. heptaseptatum**, FL.

FERN, MAIDENHAIR (*Adiantum*)

LEAF SPOT. **Mycosphaerella** sp., FL; **Phytophthora ramorum**, CA.
ROT. **Sclerotium deciduum** (*Rhizoctonia* sp.), WI.
VIRUS. **Cucumovirus**, OH.

FERN, OSMUNDA (*Osmunda*; Cinnamon, Interrupted, and Royal Ferns)

LEAF BLISTER. **Taphrinia higginsii**, GA.
LEAF SPOT. **Gloeosporium osmundae**, MI.
NEMATODE, Foliar. **Aphelenchoides fragariae**, SC.
RUST. **Uredinopsis osmundae** (II, III), northeastern and Great Lakes states, and to FL, and AL; 0,I on balsam fir.
SMUT, Inflorescence. **Mycosyrinx osmundae**, MI, NY, WI.

FERN, OSTRICH (*Pteretis*)

LEAF BLISTER. **Taphrinia hiratsukae**, WI.
ROT, Stem Necrosis. **Ceratobasidium anceps** (*Rhizoctonia*), WI.
RUST. **Uredinopsis struthiopteridis** (II, III), NY, VT, WI; 0, I on balsam fir.

FERN, POLYPODY (*Polypodium*)

LEAF SPOT. **Alternaria polypodii**, secondary, NY; **Cercospora phyllitidis**, FL; **Phyllosticta** sp., VA.
NEMATODE, Leaf. **Aphelenchoides fragariae**.
RUST. **Milesia laeviuscula** (II, III), CA, and **M. glycyrrhiza**, AK, OR, WA; **M. polypodophila** (II, III), CT, ME, MA, NH, NY, PA, TN, VT.

FERN, ROCK-BRAKE (*Cryptogramma*)

RUST. **Hyalopsora cheilanthis** (II, III), IA, MI, MT, WI; **Milesia darkeri** (II, III), CA, OR.

FERN, SENSITIVE (*Onoclea*)

DODDER. **Cuscuta gronovii**, NY.
LEAF BLISTER. **Taphrinia filicina**, NY; **T. hiratsukae**, NY, PA.
RUST. **Uredinopsis mirabilis** (II, III), ME to VA, NE, MN; 0, I on balsam fir.

FERN, TREE (*Cibotium*)

LEAF SPOT. **Pestalotia cibotii**, NJ.

FERN, WALKING (*Camptosorus*)

LEAF SPOT. **Cercospora camptosori**, WI.

FERN, WOOD, SHIELD (*Dryopteris*)

LEAF BLISTER, Gall. **Taphrina californica**, CA, OR; **T. filicina**, NY, PA; **T. fusca**, NJ, VT, WV; **T. gracilis**, NY; **T. lutescens**, ME, MN, NY, WI.
LEAF SPOT. **Cylindrocladium pteridis**, FL; Tar Spot, **Cryptomycina pteridis**, FL; **Herpobasidium filicinum**, white mold.
NEMATODE, Leaf. **Aphelenchoides fragariae**.

RUST. **Hyalopsora aspidiotus** (II, III), ME to NC, WA, WI; 0, I on balsam fir; **Milesia dilatata** (II, III), OR; **M. fructuosa** (II, III), ME, MA, NH, NY, VT; **M. marginalis** (II, III), MA, NH, VT; **Uredinopsis atkinsonii** (II, III), ME to MS, NE, ND; **U. phegopteridis** (II, III), ME, NH, WI; 0, I on balsam fir.

FERN, ROCK (*Woodsia*)

RUST. **Hyalopsora polypodii** (II, III), ID, MI; 0, I unknown.

FERN, WOODWARDIA, CHAIN (*Woodwardia*)

RUST. **Uredinopsis arthurii** (II, III), VT to AL, IN, MI, and var. **maculata**, ME to AL; 0, I unknown.

FEVERFEW (*Chrysanthemum parthenium*)

POWDERY MILDEW. **Golovinomyces cichoracearum**, NY.
ROT, Root and Stem. **Rhizoctonia solani**, WA.

FIG (*Ficus carica*)

ANTHRACNOSE; Fruit Rot. **Colletotrichum gloeosporioides** (*Glomerella cingulata*), NC to TX.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA, FL, TX.
BLOTCH, Leaf. **Cercospora fici**, NC to FL, TX.
BLIGHT, Limb. **Corticium salmonicolor**, Gulf states.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.
BLIGHT, Thread. **Pellicularia koleroga**, FL, LA, MS; Web, **P. microsclerotia**, FL to LA, TX.
BLIGHT, Twig. **Gibberella baccata**, CA.
CANKER; DIEBACK. **Botryosphaeria ribis**; **Diplodia sycina**, NC, OR; **Macrophoma fici**, also fruit dry rot, LA, NC, TX; **Nectria cinnabarina**, TX; **Megalonectria pseudotrichia**, LA, TX; **Physalospora rhodina**, AL, FL, TX; **Sclerotinia sclerotiorum**, CA, TX.
CANKER, Felt Fungus. **Septobasidium** spp., MS.

CANKER, Phomopsis. **Phomopsis cinerescens**, CA.

LEAF SPOT. **Colletotrichum elastica**, FL; **Corynespora cassiicola**, FL; **Ascochyta caricae**, CA; **Alternaria** sp., SC; **Cephalosporium acremonium**, LA; **Eutypa** sp., TX; **Mycosphaerella bolleana**, NC to TX; **Ormathodium fici**, LA.

NEMATODE, Dagger. **Xiphinema index**, CA.

NEMATODE, Fig Cyst. **Heterodera fici**, CA.

NEMATODE, Lesion. **Pratylenchus vulnus**, **P. musicola** and **P. pratensis**, CA.

NEMATODE, Pin. **Paratylenchus hamatus**, CA.

NEMATODE, Root Knot. **Meloidogyne** spp., southern states to CA.

NONPARASITIC. **Chlorosis**. Manganese deficiency, FL.

Little Leaf. Zinc deficiency, CA.

Sunburn. Low temperature injury to trunk and branches, CA.

ROT, Fruit. **Alternaria tenuis**, in market; **Aspergillus niger**, black mold; **Botrytis cinerea**; **Choanephora cucurbitarum**, TX; **Cladosporium herbarum**, market; **Diplodia natalensis**, TX; **Fusarium moniliforme**, CA; **Oospora** sp., sour rot, TX; **Rhizopus nigricans**, CA, Gulf states; **Trichothecium roseum**, Gulf states.

ROT, Root. **Armillaria mellea**, CA; **Dematophora necatrix**, NC; **Phymatotrichum omnivorum**, TX; **Rhizoctonia** sp., TX.

RUST. **Cerotelium** (*Physopella*) **fici** (II, III), NC to FL. AR, TX.

SOOTY MOLD. **Capnodium** sp., TX; **Fumago vagans**, Gulf states.

VIRUS. **Fig Mosaic**, CA, GA, TX, VA.

WILT, Branch. **Hendersonula toruloides**, CA.

FIG, FLORIDA STRANGLER (*Ficus aurea*)

ANTHRACNOSE. **Colletotrichum gloeosporioides**, FL.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, FL.

LEAF SPOT. **Ophiodothella fici**, FL; **Phlyctema ficuum**, FL; **Phyllosticta physopellae**; **P. roberti**, FL.

NEMATODE, Root Knot. **Meloidogyne** spp.

ROT, Fruit. **Fusarium moniliforme**, CA.

RUST. **Cerotelium fici** (II, III), FL.

FIGWORT (*Scrophularia*)

DOWNY MILDEW. **Peronospora sordida**, CA, IL, NY, VA to KS.
LEAF SPOT. **Cylindrosporium scrophulariae**, IL, OK, PA; **Mycosphaerella** sp., KS; **Septoria scrophulariae**, CA, CO, OR, WA, NY to MS.
VIRUS. **Figwort Mosaic**.

FILAREE, RED-STEM (*Erodium cicutarium*)

NEMATODE, Lesion. **Pratylenchus minyus**, CA.
VIRUS. **Filaree Red Leaf**, CA.

FILBERT

► Hazelnut.

FIR (*Abies*)

BLACK MILDEW. **Dimerosporium abietis**, ID, OR, WA; **Adelopus nudus**, ME, NY, NC, WI.
BLIGHT. **Phoma eupyrena**, CA.
BLIGHT, Brown Felt. **Herpotrichia nigra**, on high western firs.
BLIGHT, Needle. **Acanthostigma parasiticum**; **Rehmiellopsis balsameae**, Northeast; **Cenangium ferruginosum**, MI, PA; **Rhabdogloeum abietinum**, NC; **Macrophoma parca**, CO, ID, MT, OR, WA; **Phoma eupyrena**, CA.
BLIGHT, Needle. **Furcaspora pinicola**, CA; **Phyllosticta multicorniculata**, NH.
BLIGHT, Seedling Smother. **Thelephora terrestris**.
BLIGHT, Snow. **Phacidium infestans**, Northeast; **P. balsameae**; **P. abietinellum**.
BLIGHT, Tip. **Delphinella balsameae**, VT.
CANKER. **Aleurodiscus amorphus**, general; **Cytospora pinastri**, ME, WI **C. cylindroides** and **C. abietis**, OR, WA; **Cephalosporium** sp., MN, WI; **Cryptosporium macrospermum**, New England; **Dasyscyphus resinaria**, MN; **Nectria fuckeliana**, CA, OR; **N. balsameae**, NC, PA; **Phomopsis boycei**, ID, MT; **P. fokoyae**, CA.; **P. montanensis**;

Ophionectria scolecospora, widespread; **Scleroderris abieticola**, OR; **Sphaeropsis abietis**, MI; **Valsa** (*Cytospora*) **kunzei**; **Thyronectria balsamea**, CO.

CANKER, Pitch. **Fusarium circinatum**, CA.

DIEBACK, Twig. **Sydowia polyspora**, CA.

MISTLETOE. **Arceuthobium americanum**, WA; **A. campylopodium**, widespread in West; **A. douglasii**, NM, OR, WA; **A. laricis**, WA; **Phoradendron pauciflorum**, AZ, CA.

NEEDLE CAST; Blight. **Bifusella abietis**, ID, MT, WA; **B. faullii**, ME, MI, NH; **Hypoderma robustum**, CA, ID, OR, WA; **Hypodermella abietis-concoloris**, widespread on western firs; **H. mirabilis**, MI; **H. nervata**, ME, NH, VT; **H. punctata**, ID, OR; **Lophodermium piceae**, tar spot, widespread, weakly parasitic; **L. autumnale**, CA, ID, MI, OR, UT, WY; **L. consciatum**; **L. decorum**; **L. uncinatum**; **L. lacerum**, NH, NY, PA, VT.

NEEDLE CAST; Blight. **Tirula nervisequa conspicuous**, CA.

NEMATODE. **Nacobbodera chitwoodi**, OR.

ROT, Heart. **Stereum sanguinolentum**, widespread; **Polyporus sulphureus**, general.

ROT, Crown. **Phytophthora cactorum**, VA.

ROT, Hypocotyl. **Fusarium oxysporum**, CA.

ROT, Root. **Armillaria mellea**, New England, NY; **Fusarium solani**, PA; **F. oxysporum**, PA; **F. avenaceum**, PA; **Phytophthora cinnamomi**, NC; **P. citricola**, NC.

ROT, Root. **Phytophthora drechsleri**, NC.

ROT, Root. **Verticicladiella wagenerii**, Pacific Coast.

ROT, Root. **Poria weirii**, OR.

ROT, Wood. **Coniophora puteana**, New England, NY; **C. corrugis**, AZ, CO, WY; **Fomes annosus**, CO; **Echinodontium tinctorium**; **Hydnum abietis**; **H. balsameum**; **Polyporus** spp.; **Poria** spp.

RUST, Fir-Broom. **Melampsorella caryophyllacearum**.

RUST, Fir-Fern. **Milesia fructuosa** (0, I) on new needles, ME, NH, NY; II, III on *Dryopteris*; **M. marginalis**, MA, NH, NY; **M. polypodophila** (0, I), ME, NH, NY, on old needles; II, III on *Polypodium*, **Hyalopsora aspidiotus** (0, I), on 2-year needles; II, III on *Dryopteris*; **Uredinopsis mirabilis** (0, I), general; II, III on sensitive fern; **U. osmundae** (0, I), widespread; II, III on *Osmunda*; **U. struthiopteridis**, ID, MI, OR, WA; II, III on ostrich-fern; **U. phegopteridis** (0, I); II, III on *Dryopteris*.

RUST, Fir-Fireweed. **Pucciniastrum pustulatum**, widespread; II, III on Epilobium.

RUST, Fir-Huckleberry. **Pucciniastrum goeppertianum**, widespread on western firs, and ME, PA, WI; II, III on *Vaccinium*.

RUST, Fir-Willow. **Melampsora abieti-capraearum**, widespread; II, III on willow.

RUST, Needle. **Caeoma faulliana**, OR; **Peridermium ornamentale**, ID, MT, OR, WA; **P. rugosum**, CA, OR, WA.

RUST, Witches' Broom. **Melampsorella cerastii**, general; II, III on chickweed.

Despite this long list of possibilities the gardener should not have much trouble with ornamental firs. Rehmiellopsis tip blight yellows needles of new growth and causes twig dieback of native balsam firs in the Northeast but can be controlled with copper sprays, which will also aid in preventing needlecast diseases. Avoid bark and branch injuries that induce cankers. Rust is taken care of, if necessary, by eliminating the proper alternate host, but only a specialist can identify the many different rust species.

FIRECRACKER PLANT (*Crossandra infundibuliformis*)

VIRUS. **Alternanthera Mosaic**, FL, MD, PA.

FIRETHORN

► Pyracantha.

FITTONIA

BLIGHT, Leaf. **Rhizoctonia** sp., OH.

LEAF SPOT. **Myrothecium roridum**, FL.

FLAX, FLOWERING (*Linum*)

DAMPING-OFF. **Rhizoctonia solani**, IL.

NEMATODE, Root Knot. **Meloidogyne** sp., CA.

ROT, Stem. **Sclerotinia sclerotiorum**, CA.

FLORIDA BEGGARWEED (*Desmonium tortuosum*)

VIRUS. **Tomato Spotted Wilt**, GA.

FLORIDA PUSLEY (*Richardia scaba*)

VIRUS. **Tomato Spotted Wilt**, GA.

FOAM-FLOWER (*Tiarella*)

POWDERY MILDEW. **Sphaerotheca macularis**, AK.
RUST. **Puccinia heucherae** (III), CT to NC, AK, CA, CO, ID, MI, MT, OR, TN, WA, WI.

FORESTIERA (Swamp-Privet)

MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
POWDERY MILDEW. **Microsphaera alni**, IL, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium minutum** (II, III), FL, TX; 0, I on pine; **Puccinia peridermiospora** (0, I), FL, TX; II, III on marsh grass.

FORGET-ME-NOT (*Myosotis*)

BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan.
DOWNY MILDEW. **Peronospora myosotidis**, IL, MI, MS, WI.
POWDERY MILDEW. **Golovinomyces cynoglossi** (*Erysiphe cynoglossi*), WA.
LEAF SPOT. **Stemphylium** sp., NY.
ROT, Crown. **Sclerotinia sclerotiorum**, IL, WA.
RUST. **Puccinia eatoniae** var. **myosotidis** (0, I), IL, IN, MS, MO, NC, WI; II, III on *Sphenopholis*; **P. mertensiae** (III), CO.
VIRUS. **Chlorosis**, GA. Perhaps eastern strain of Aster Yellows.

FORSYTHIA (Goldenbells)

ANTHRACNOSE. **Gloeosporium** sp., OK.
BACTERIAL Grown Gall. **Agrobacterium tumefaciens**, MS, NJ, TX.
BLIGHT, Cane. **Botryosphaeria ribis**.
BLIGHT, Southern. **Sclerotium rolfsii**, GA.
BLIGHT, Twig. **Sclerotinia sclerotiorum**, NC; **Phytophthora nicotianae**, VA.
CANKER, Stem Gall. **Phomopsis** sp., KY.
LEAF SPOT. **Alternaria** sp., IA; **Phyllosticta discincola**, MD.
NEMATODE, Lesion. **Pratylenchus vulnus**.
NEMATODE, Root Knot. **Meloidogyne** sp., TX; **M. hapla**; **M. incognita-acrita**.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Tobacco Ring Spot**, MD.

FOUQUIERIA (Ocotillo, Candlewood)

ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Aecidium cannonii** (0, I), AZ.

FOUR-O'CLOCK (*Mirabilis*)

BACTERIAL, Blight. **Xanthomonas campestris** pv. **campestris**, CA.
LEAF SPOT. **Cercospora mirabilis**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Aecidium mirabilis** (0, I), AZ, NM; **Puccinia aristidae** (0, I), AZ.
VIRUS. **Beet Curly Top**, CA; **Mirabilis Mosaic**, IL.
WHITE RUST. **Albugo platensis**, TX.

FOXGLOVE (*Digitalis*)

ANTHRACNOSE. **Colletotrichum fuscum**, CT, MA, OR, PA, WI.
BLIGHT, Leaf; Inflorescence. **Alternaria** sp., MD.
DOWNY MILDEW. **Peronospora digitalidis**, CA.

LEAF SPOT. **Cladosporium** sp., NJ; **Phyllosticta digitalis**, AK, NY, TX; **Ramularia variabilis**, OR.
NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CT.
NEMATODE, Root Knot. **Meloidogyne** spp., CA, MD.
ROT, Root and Stem. **Rhizoctonia solani**, NJ; **Fusarium** sp., CA, NH.
ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, NY; **Sclerotium rolfsii**, IN, NJ, TX.
VIRUS. **Tobacco Mosaic**, WI; **Tomato Spotted Wilt**, PA; **Tomato Spotted Wilt-Impatiens Serotype**, FL, GA.
WILT. **Fusarium** sp., CA, NH; **Verticillium albo-atrum**, NY.

FREESIA

BACTERIAL Scab. **Pseudomonas marginata**, occasional in imported stock.
LEAF SPOT. **Heterosporium iridis**, CT.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
ROT, Corm Wilt. **Fusarium** spp., including **F. oxysporum**; **F. solani**, CA, FL, TX.
ROT, Dry. **Stromatinia gladioli**, NJ, NY.
ROT. Blue Mold. **Penicillium gladioli**.
RUST. Cause unknown, not true rust.
VIRUS. **Iris Mosaic**, CA; **Bean Yellow Mosaic**.
Fusarium corm rot causes wilting and death. Corms should be inspected before planting, and all those showing pinkish lesions should be discarded.

FREEWAY DAISY (*Osteospermum*)

VIRUS. **Lettuce Mosaic**, CA.

FREMONTIA (Flannel Bush)

LEAF SPOT. **Ascochyta fremontiae**, CA.
ROT; Stem Girdle. **Phytophthora cactorum**, CA.
ROT, Crown, Root. **Phytophthora nicotianae** var. **nicotianae**, CA.
WILT. **Verticillium albo-atrum**, CA.

FRINGE-TREE (*Chionanthus*)

ANTHRACNOSE. **Discola fraxinea**, DE.
LEAF SPOT. **Cercospora chionanthi**, NJ to NC, WV; **Phyllosticta chionanthi**, NJ, WV; **Septoria chionanthi** and **S. eleospora**, SC, TX.
POWDERY MILDEW. **Phyllactinia corylea**, MD.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Daedalea confragosa**, MD.

FRITILLARIA

LEAF SPOT. **Phyllosticta fritillariae**, CA.
RUST. **Uromyces miurae** (III), AK, WA.
VIRUS. **Mosaic**. Undetermined, NY.

FROELICHIA

LEAF SPOT. **Cercospora crassoides**, OK, TX, WI.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
WHITE RUST. **Albugo froelichiae**, NE, TX.

FROSTWORT (*Crocanthemum*)

LEAF SPOT. **Cylindrosporium eminens**, WI.

FUCHSIA

BLIGHT, Gray Mold. **Botrytis cinerea**, AK, WV.
DIEBACK. **Phomopsis** sp., VA.
LEAF SPOT. **Septoria** sp., OK.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Mushroom Root. **Armillaria mellea**, CA.
ROT, Root. **Pythium rostratum**; **P. ultimum**, CA; **Phytophthora parasitica**, OR; **Thielaviopsis** sp., OR.
RUST. **Pucciniastrum epilobii**, NC, OR; **Uredo fuchsiae** (II), OH.
VIRUS. **Tomato Spotted Wilt**, CA; **Cucumber Mosaic**, MN.

WILT. **Verticillium albo-atrum**, CA.
Verticillium wilt is common in garden plantings of fuchsia in California.

GAILLARDIA (Blanket Flower)

BACTERIAL, MLO. **Aster Yellows**, NJ, NY, PA, and **California Aster Yellows**, CA.
LEAF SPOT. **Septoria gaillardiae**, IA, OK, TX.
NEMATODE. **Naccobus batatiformis**, NE.
POWDERY MILDEW. **Golovinomyces cichoracearum**, MT, OK, TX; **Sphaerotheca macularis**, MT, WA, WY; **Leveillula taurica**, WA.
ROT, Crown and Stem. **Sclerotinia sclerotiorum**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium ultimum**, CA.
RUST. **Coleosporium asterum** (II, III), CA; 0, I on pine; **Puccinia gaillardiae** (0, I), CA, II, III unknown.
SMUT, White. **Entyloma polysporum**, KS, MN, NE, VA.
VIRUS. **Tomato Spotted Wilt**, CA; **Bidens Mottle**, FL.

GALAX

LEAF SPOT. **Clypeolella leemingii**, black spot, MD to GA, MS; **Discohainesia oenotherae**, NC; **Phyllosticta galactis**, NC, VA, WV.

GALIUM (Bedstraw)

DODDER. **Cuscuta cuspidata**, TX.
DOWNY MILDEW. **Peronospora calotheca**, IA, ND, WI.
LEAF SPOT. **Cercospora galii**, AL, AK, IA, NH, NY, OR; **Pseudopeziza repanda**, CA, CT, GA, IL, IA, NY, ND, OR, WI; **Melasmia galii**, IA; **Septoria cruciatae**, IN, MI, NJ, NY, WV, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, MT, OR, PA, WA; **Erysiphe polygoni**, KS.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia difformis** (0, I, III), OH to KS, MT, Pacific Coast; **P. punctata** (0, I, II, III); CT, MS, NC, ND to CA,WA; **P. punctata** var. **troglodytes** (0, I), CT to MO, SD, WA; **P. rubefaciens** (III), AK,

IA, WI to CA, WA; **Pucciniastrum galii**, NY, PA to CA, CO, and OR; **Uromyces galii-californici** (II, III), CA.

GALTONIA (Summer-Hyacinth)

VIRUS. **Ornithogalum Mosaic**, OR.

GARDENIA (Cape-Jasmine)

BACTERIAL Leaf Spot. **Xanthomonas maculifolium-gardeniae**, CA.

BLIGHT, Bud Rot. **Botrytis cinerea**, in greenhouses; outdoors in CA.

CANKER, Stem Gall. **Phomopsis** (*Diaporthe*) **gardeniae**, CA, widespread in greenhouses, outdoors in CA, FL.

LEAF SPOT. **Myrothecium roridum**, PA; **Pestalotia langloisii**, AL, FL; **Phyllosticta** sp., MS, NJ, TX; **Rhizoctonia** sp., NJ; **Mycosphaerella gardeniae**, GA.

LEAF SPOT, Algal. **Cephaleuros virescens**, Gulf states.

NEMATODE, Burrowing. **Radopholus similis**, FL.

NEMATODE, Reniform. **Rotylenchulus reniformis**.

NEMATODE, Root Knot. **Meloidogyne hapla**; **M. incognita**; **M. javanica**; general; **M. arenaria**, NC.

NEMATODE, Spiral. **Helicotylenchus nannus**.

NONPARASITIC. **Bud Drop**. Excessive soil moisture; temperature fluctuation.

Chlorosis. Soil too alkaline or soil temperature too low.

Dieback. Yellow veinbanding, defoliation from root smothering by overwatering.

POWDERY MILDEW. **Erysiphe polygoni**, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX

SOOTY MOLD. **Capnodium** spp., Gulf states.

In the deep South gardenia foliage is disfigured with sooty mold growing in whitefly honeydew. Gardenias are difficult house plants, dropping buds with uneven humidity and temperature. To control Phomopsis canker take cuttings near top of plants. Substitute the more resistant Veitchii variety for susceptible Belmont and Hadley. Avoid syringing, which spreads bacterial leaf spot.

GARLIC (*Allium sativum*)

(see Onion)

RUST. **Puccinia allii**, OR; on wild garlic, CA.
VIRUS. **Onion Yellow Dwarf, Leak Yellow Stripe, Garlic Common Latent**, WA; **Leaf Yellow Strip, Mosaic, Dwarfism**, Guanajuato, Mexico; **Leaf Yellow Strip Virus**.
Subject to diseases of onion. White rot is serious in Louisiana; pink root is a common problem. Clove rot is caused by *Penicillium digitatum*.

GARRYA (Tassel-Tree, Silk-Tassel Bush)

LEAF SPOT. **Cercospora garryae**, CA, TX; **Phyllosticta garryae**, CA, TX; **Dothichiza garryae**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
SOOTY MOLD. **Lembosia lucens**, CA.

GAULTHERIA (Checkerberry, Teaberry) (Source of Oil of Wintergreen)

BLOTCH, Sooty. **Gloeodes pomigena**, WI.
FRUIT SPOT; Black Speck. **Leptothyrella pomi**, WI; **Schizothyrium gaultheriae**, ME to VA, WI.
LEAF SPOT. **Cercospora gaultheriae**, NJ, WI; **Discohainesia oenotherae**, VA; **Mycosphaerella gaultheriae** (*Phyllosticta gaultheriae*), general; **Venturia arctostaphyli**, MD, MA, NJ, NY, VA.
POWDERY MILDEW. **Microsphaera alni**, MD.

GAURA

BACTERIAL, MLO. **California Aster Yellows**, CA.
BROOMRAPE. **Orobanche ramosa**, TX.
DOWNY MILDEW. **Peronospora arthuri**, KS, NE.
GALL, Leaf. **Synchytrium fulgens**, TX.
LEAF SPOT. **Cercospora gaurae**, NY, OK, TX; **Septoria gaurina**, IL, KS, NE, ND, OK, TX.

POWDERY MILDEW. **Erysiphe polygoni**, CO, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia extensicola** var. **oenotherae** (0, I), CO, NE, TX; II, III on Carex spp.; **Uromyces plumbarius** (0, I, II, III), NY to VA, TX, WI, ND and MT to MSNM.

GAZANIA

ROT, Crown. **Rhizoctonia solani**, CA; **Sclerotinia sclerotiorum**, LA.
VIRUS. **Lettuce Mosaic**, CA; **Tomato Spotted Wilt-Lettuce Serotype**, GA.

GAZANIA (Treasure flower)

ROT, Crown. **Sclerotinia sclerotiorum**, LA.

GENISTA (Wood-waxen)

DIEBACK. **Diplodia** sp., CA, NJ.
LEAF SPOT. **Pleiochaeta setosa**, OR.
POWDERY MILDEW. **Erysiphe polygoni**, MO.
RUST. **Uromyces genistae-tinctoriae** (II, III), CA.

GENTIAN (*Gentiana*)

BLIGHT, Stem Canker. **Botrytis cinerea**, NY.
LEAF SPOT. **Asteromella andrewsii** (*Mycosphaerella andrewsii*), DE, IL, IA, NE, NJ, D, PA, WV, WI; **Cercospora gentianae**, NY, ND, VT; **C. gentianicola**, DE, WI.
ROT, Root. **Fusarium solani**, MD.
RUST. **Puccinia gentianae** (0, I, II, III), NY to IN, NE, MN; western states to AK, CA, WA; **P. haleniae**, WY; **Uromyces gentianae** (II, III), CO, IA, NV, NM, NC, VT, WA, WY; **Pucciniastrum alaskanum**, AK.

GERANIUM (*Pelargonium*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD, MA, OH.

BACTERIAL Fasciation. **Clavibacter fascians**, IN, MA, OH, OR.

BACTERIAL Leaf Spot. **Xanthomonas pelargonii**, MA to VA, CA, MS, OH, WA; **Pseudomonas cichorii**, FL.

BACTERIAL Wilt, Southern. **Pseudomonas solanacearum**, NC; **Ralstonia solanacearum**, Race 3, Biovar 2, CT, DE, PA.

BLIGHT, Blossom; Gray Mold; Cutting Rot. **Botrytis cinerea**, cosmopolitan.

LEAF SPOT. **Alternaria** sp., secondary; **Ascochyta** sp., CT, NJ; **Cercospora brunkii**, FL, MD, OH, NH, TX; **Pleosphaerulina** sp., PA.

MOLD, Leaf. **Botryosporium pulchrum**, occasional in greenhouses.

NEMATODE, Dagger. **Xiphinema americanum**.

NEMATODE, Leaf. **Aphelenchoides** sp., NY.

NEMATODE, Root Knot. **Meloidogyne** spp., CT, FL, NJ, OH, OR.

NONPARASITIC. **Oedema**, Dropsy. Intumescence from excessive soil moisture and retarded transpiration.

Crook-Neck. Chimeral mutation.

PETAL AND LEAF SPOT. **Bipolaris** (*Helminthosporium*) **setariae**, FL.

ROT, Blackleg, Stem and Cutting Rot. **Pythium debaryanum**, **P. mamillatum**, **P. splendens**, **P. ultimum**, **P. vexans**, cosmopolitan; **Rhizoctonia solani**, cosmopolitan; **Aspergillus fischeri**, CA; **Fusarium** sp., IN, NY, WA.

ROT, Root. **Thielaviopsis basicola**, CT; **Armillaria mellea**, CA; **Pythium aphanidermatum**, PA; **P. dissotocum**, PA: **P. ultimum**, PA; **P. heterothallicum**, PA; **P. irregulare**, PA; **P. myriotylum**, PA.

RUST, Pelargonium. **Puccinia pelargonii-zonalis** (II), CA, FL, NY, PA.

VIRUS. **Pelargonium Leaf Curl** (Geranium Crinkle), general; **Geranium Mosaic**; **Cucumber Mosaic**; **Beet Curly Top**; **Tomato Spotted Wilt**, CA, OK, TX; **Tomato Ring Spot**; **Tobacco Ring Spot**; **Pelargonium Flower Break**; **Pelargonium Line Pattern**.

WILT. **Verticillium albo-atrum**, CA, NY, OR.

The dry air of the average home makes foliage diseases due to pathogenic organisms unlikely but sometimes a water-logged soil and cloudy weather, with less evaporation, leads to oedema, small swellings in leaves, corky ridges on petioles. Botrytis blight and bacterial leaf spots may be expected in greenhouses unless plants are spaced widely, have proper air circulation, little overhead watering, and all infected plants or parts speedily removed. Start with clean cuttings from a culture-indexed mother block.

GERANIUM (Cranesbill, Herb-Robert)

BACTERIAL Leaf Spot. **Pseudomonas erodii**, FL, IL, IN, OR, TX; **Xanthomonas geranii**, NY.

BLIGHT, Leaf Spot; Stem Rot. **Botrytis cinerea**, KS, MO.

BROOMRAPE. **Orobanche ramosa**, TX.

DOWNY MILDEW. **Plasmopara geranii**, NJ to FL, KS, TX, MA to IA, MT, UT, WI.

GALL, Leaf. **Synchytrium geranii**, LA, OK, TX.

LEAF SPOT. **Cercospora geranii**, CO, IA, KS, MO, MT, NY, TX, UT, WI; **Cylindrosporium geranii**, LA; **Dilophospora geranii**, WI; **Pestalozziella subsessilis**, MS, MO, NJ, WI; **Phyllosticta geranii**, LA, TX; **Ramularia geranii**, CA, LA, WA, WY; **Septoria expansa**, KS, TX; **Stigmatea geranii**, black leaf speck, MD; **Venturia circinans**, mold, AK.

POWDERY MILDEW. **Erysiphe polygoni**, CO, IL, IN, OH, PA, WV, WI, WY; **Sphaerotheca macularis**, CA, ID, MN, MT, NE, PA, WA, WI, WY.

ROT, Rhizome. **Seaverinia geranii**, NY, OH, WI.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia leveillei** (III), CO, MT, UT, WA, WY; **P. polygoni-amphibii** (0, I), CT to WI, KS, MN, MO, MT, TX; II, III on Polygonum; **Uromyces geranii** (0, I, II, III), AK, ME, WY.

VIRUS. **Cucumber Mosaic**, FL.

GERBERA (Transvaal Daisy)

BLIGHT, Flower; Ray Speck. **Alternaria dauci** f. sp. **solani**, FL.

BLIGHT, Gray Mold. **Botrytis cinerea**, FL, NY.

LEAF SPOT; Stem Rot. **Gloeosporium** sp., NY.

NEMATODE, Root Knot. **Meloidogyne** sp., AL, CA, MD, NY, NC.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, OK.

ROT, Crown. **Sclerotinia sclerotiorum**, MD, NY.

ROT, Root and Stem. **Phytophthora cryptogea** and **P. drechsleri**, CA, NJ, NY; **Pythium irregulare**, CA.

VIRUS. **Tobacco Rattle**, FL; **Tomato Spotted Wilt-Impatiens Serotype**, FL.

GERMANDER (*Teucrium*)

DOWNY MILDEW. **Peronospora** sp., OK.
LEAF SPOT. **Cercospora teucrii**, NY to MS, TX, WI; **Phyllosticta decidua**, TX, WI.
NEMATODE, Root Knot. **Meloidogyne hapla**.
POWDERY MILDEW. **Golovinomyces cichoracearum**, IL, PA, WI.
RUST. **Puccinia menthae** (0, I, II, III), PA.

GEUM (*Avens*)

BACTERIAL, MLO. **California Aster Yellows**, CA.
DOWNY MILDEW. **Peronospora potentillae**, CA, IL, IN, IA, KS, NE, WI.
GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Cercospora gei**, WI; **Cylindrosporium gei**, NH, WI; **Marssonina adunca**, MT, WA; **Phyllosticta** sp., WV, WI; **Ramularia gei**, MO, WI; **Septoria gei**, AK, DE, IL, MI, NE, NY, OH.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
POWDERY MILDEW. **Erysiphe polygoni**, AK; **Sphaerotheca macularis**, IN, MD, NE, NY, ND, OH, PA, WA, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia sieversii**, CO.
SMUT, Leaf. **Urocystis** (*Whetzelia*) **waldsteiniae**, MT, WA.

GILIA (Skyrocket)

BACTERIAL, MLO. **California Aster Yellows**, CA.
DOWNY MILDEW. **Peronospora giliae**, TX.
LEAF SPOT. **Ramularia giliae**, OR.
NEMATODE, Lesion. **Pratylenchus pratensis**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
NEMATODE, Stem. **Ditylenchus dipsaci**.
POWDERY MILDEW. **Sphaerotheca macularis**, CA, TX, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia aristidae** (0, I), AZ, CO; **P. giliae** (II, III), AZ, CA, CO, NE, OR, WA; 0, I, unknown; **P. plumbaria** (0, I, III), CA, CO, NE, UT, WY; **P. yosemitana** (0, III), CA, CO.

GILLENIA (American Ipecac, Indian Physic)

RUST. **Gymnosporangium exterum** (0, I), IN, KY, MO, NC, TN, VA, III on red-cedar.

GINGER, EDIBLE (*Zingiber*)

BACTERIAL, Rhizome Rot. **Enterobacter cloacae**, HI.

GINGER, WILD (*Asarum*)

GALL, Leaf. **Synchytrium asari**, CA, MN, WI.

LEAF SPOT. **Ascochyta versicolor**, ID; **Plagiostoma** (*Laestadia*) **asarifolia**, SC.

ROT, Rhizome. **Sclerotinia sclerotiorum**, NY.

RUST. **Puccinia asarina**, CA, ID, OR, WA.

GINKGO (Maidenhair-Tree)

ANTHRACNOSE. **Glomerella cingulata**, MD, TX.

BACTERIAL LEAF SPOT, Canker Stem. **Pseudomonas syringae** pv. **syringae**, CA.

LEAF SPOT. **Phyllosticta ginkgo**, PA; **Epicoccum purpurascens**, IL.

NEMATODE, Root Knot. **Meloidogyne** sp., MS.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Sapwood. **Polyporus hirsutus**; **P. lacteus**; **P. tulipiferae**; **P. versicolor**; **Fomes connatus**, MD.

ROT, Seed. **Xylaria longeana**, PA.

GINSENG (*Panax*)

BLIGHT. **Alternaria panax**, general; **Botrytis cinerea**, NY to NC, MI, WA.

DAMPING-OFF. **Pythium debaryanum**, NY; **Rhizoctonia solani**, AR, IN, MI, NJ, NY, WA.

LEAF SPOT. **Septoria** sp.; **S. araliae**, WI; **Colletotrichum dematium**, secondary, NY to NC, MN, MO.

NEMATODE, Root Knot. **Meloidogyne** sp., CT, MI, NY, OH, PA, WI.

NONPARASITIC. **Papery Leaf**. Moisture deficiency, sunscald, MI, MO, NJ, NY, PA.

POWDERY MILDEW. **Erysiphe panax**.

ROT, Rhizome. **Sclerotinia sclerotiorum**, white rot, MI, NY, OH, PA, WA, WI; **S. smilacina**, black rot, MI, MN, NY, WI.

ROT, Root. **Armillaria mellea**, WA; **Fusarium scirpi**, NY to AL, MO, WA, WI; **Phytophthora colocasiae**, NC; **Thielaviopsis basicola**, black root, IL, MI, NJ, NY, OH; **Ramularia** spp., MI, NY, OR, WA, WI.

ROT, Stem, Root; Downy Mildew. **Phytophthora cactorum**, CT to NC, IA, MI, WA.

RUST. **Puccinia araliae** (III), MA, PA.

WILT. **Verticillium albo-atrum**, IN, KY, MI, NJ, NY, OH, PA, TN, WI.

GLADIOLUS

BACTERIAL Leaf Blight. **Xanthomonas gummisudans**, NY to MO, ND, WA.

BACTERIAL, MLO. **Aster Yellows**, MD.

BACTERIAL Scab; Neck Rot; Leaf Spot. **Pseudomonas marginata**, general.

BACTERIAL Soft Rot. **Erwinia carotovora**, MI.

BLIGHT, Leaf; Flower Spot; Corm Rot. **Botrytis gladiolorum**, AK, CA, FL, MA, MD, NJ, NY, OR, WA, WI.

BLIGHT, Seedling. **Botrytis elliptica**, WA.

BLIGHT, Brown Spot of leaves, flowers. **Curvularia lunata** (*Cochliobolus lunata*), FL, MD, MI, NY, NC, VA, WI.

BLIGHT, Southern. **Sclerotium rolfsii**, FL.

LEAF SPOT. **Alternaria** spp., cosmopolitan; **Cladosporium herbarum**, cosmopolitan but secondary; **Heterosporium** sp., MD; **Stemphylium** sp., leaf and stem spot, FL, MI, NJ, NY.

NEMATODE, Root Knot. **Meloidogyne** spp., NC to FL, TX; **M. hapla**.

NEMATODE, Sheath. **Hemicycliophora oracilis**, OR.

NONPARARASITIC **Leaf Scorch**. Atmospheric fluorides, WA.

Brown Tip. From waterlogged soil.

Ink Spot. On husks and corms. Cause unknown.

"**Rust**.". Spot necrosis on leaves, from sun on water drops.

Topple. Partially controlled by spraying flowers with calcium nitrate.

ROT, Corm, Basal; Yellows; Wilt. **Fusarium oxysporum** f. sp. **gladioli**, general.
ROT, Dry, of corms; Leaf and Stalk Rot. **Stromatinia gladioli**, general.
ROT, Hard; Leaf Spot. **Septoria gladioli**, general.
ROT, Root, Collar, Leaf Base. **Rhizoctonia solani**, NJ, ND, TX.
ROT, Storage. **Penicillium gladioli**, general in the North, occasional in the South; **P. funiculosum**, core rot; **Rhizopus arrhizus**, soft, occasional.
RUST, **Uromyces transversalis**, Mexico (Michoacan), FL.
SMUT. **Urocystis gladiolicola**, CA.
VIRUS. **Cucumber Mosaic**; **Yellow Bean Mosaic** (mild mosaic); **White Break**, NY to IL, CA, WA; **Tomato Ring Spot**.

The backyard gardener with a few rows of gladiolus probably sprays for thrips and forgets about diseases, but the serious grower has much to combat. Control starts with choosing varieties resistant to Fusarium yellows, treating corms after digging and before planting to control rots and scab, with removal of husks usually giving a healthier crop, and field spraying for Botrytis, Curvularia, and Stemphylium flower blights and leaf spots. Mild mosaic is spread from beans to gladiolus by aphids; so they should be kept widely separated. Rogue plants with white-break mosaic. An aluminum mulch repels aphid vectors of virus diseases.

GLOBE-AMARANTH (*Gomphrena*)

LEAF SPOT. **Cercospora gomphrenae**, GA, OK, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
VIRUS. **Beet Curly Top**, TX; **Tomato Spotted Wilt-Impatiens Serotype**, FL, GA.
WHITE RUST. **Albugo bliti**, NM.

GLOBE-MALLOW (*Sphaeralcea*)

POWDERY MILDEW. **Erysiphe polygoni**, ID.
RUST. **Puccinia interveniens**, ID, WA; **P. schedonnardi**, AZ, NM; **P. sherardiana**, AZ, CA, CO, ID, NE, NM, TX, UT, WY; **P. sphaeralceae** (I, III), CA.

GLOBE-THISTLE (*Echinops*)

ROT, Crown. **Sclerotium rolfsii**, CT.
ROT, Root. **Phytophthora cryptogea**, NC.

GLORY-BUSH (*Tibouchina*)

ROT, Mushroom Root. **Clitocybe tabescens**, FL.

GLOXINIA (*Sinningia*)

BACTERIAL Leaf Blight. **Pseudomonas** sp., OR.
BACTERIAL Leaf Spot. **Pseudomonas alcaligenes**, FL.
BACTERIAL, MLO. **Aster Yellows**, CA.
BLIGHT, Bud Rot. **Botrytis cinerea**, CA, MO.
NONPARASITIC. **Dieback Wilt**; Boron deficiency, CA.
ROT, Crown; Flower, Leaf Blight. **Sclerotinia sclerotiorum**, CA.
ROT, Leaf. **Cladosporium herbarum**, NJ.
ROT, Root and Crown. **Phytophthora cryptogea**, CA; **Pythium ultimum**, CA; **Myrothecium roridum**, FL.
VIRUS. **Tomato Spotted Wilt**, CA, MO, NC, TX; **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA; **Impatiens Necrotic Spot**, NC.

GNAPHALIUM (Cudweed)

BACTERIAL, MLO. **California Aster Yellows**;
CANKER, Stem. **Phoma erysiphoides**, TX, WI.
DOWNY MILDEW. **Plasmopara halstedii**, AL, MS.
LEAF SPOT. **Cercospora gnaphaliacea**, KS, MS; **Cylindrosporium gnaphalicola**, AL, TX; **Septoria cercosperma**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia gnaphaliicola** (II, III), AL, LA, NC, SC; 0, I unknown; **P. investita** (0, I, III), AZ, CA, CT, MA, NY, OH, PA, TN, VT, WV, WI.
SMUT, White. **Entyloma compositarum**, AL, MD.
VIRUS. **Beet Curly Top**, CA; **Tomato Spotted Wilt**, GA.

GOATS-BEARD (*Aruncus*)

LEAF SPOT. **Cercospora** sp., OR; **Ramularia ulmariae**, AK.

GODETIA

BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
DAMPING-OFF. **Rhizoctonia solani**, IL.
DOWNY MILDEW. **Peronospora arthuri**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Root. **Pythium ultimum**, MO; **Phytophthora cryptogea**.
RUST. **Puccinia oenotherae** (0, I, II, III); **P. pulverulenta** (0, I, II, III), CA; **Pucciniastrum epilobii** (II, III), AK; 0, I on fir.
VIRUS. **Tomato Spotted Wilt**, CA.

GOLDEN-CHAIN (*Laburnum*)

BLIGHT, Twig. **Gibberella baccata**, NJ; **Fusarium** sp., MD, OH.
CANKER, Stem. **Diplodia mutila**, OH.
LEAF SPOT. **Cercospora laburni**, OK.

GOLDEN-CLUB (*Orontium*)

BLIGHT, Leaf. **Botrytis streptothrix**, NJ.
LEAF SPOT. **Mycosphaerella** sp., NJ; **Phyllosticta orontii**, NJ, TX; **Ramularia orontii**, NJ; **Volutella diaphana**, NJ.

GOLDEN-EYE (*Viguiera*)

POWDERY MILDEW. **Golovinomyces cichoracearum**, UT.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Helicobasidium purpureum**, TX.
RUST. **Puccinia abrupta** (II, III) AZ, TX; **P. tumidipes** (II, III), AZ, CA.
SMUT, White. **Entyloma compositarum**, UT.

GOLDEN-GLOW (*Rudbeckia lacinata*)

BACTERIAL, MLO. **Aster Yellows**; **California Aster Yellows**.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.
DOWNY MILDEW. **Plasmopara halstedii**, IA, NE, NC, ND, WI.
GALL, Leaf. **Synchytrium aureum**, IL, WI.
LEAF SPOT. **Cercospora rudbeckiae**, NY; **Phyllosticta rudbeckiae**, IA, NY, WI; **Ramularia rudbeckiae**, VT to MS, CO and ID; **Septoria rudbeckiae**, KS, NE, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Stem. **Sclerotinia sclerotiorum**, CT.
RUST. **Puccinia dioicae** (0, I), MO, SD; **Uromyces perigynius** (0, I), MD to MO, MT; II, III on *Carex*; **U. rudbeckiae** (III), MD to MS, NM, MT.
SMUT, White. **Entyloma compositarum**, IA, MO, OH, WI.
VIRUS. **Potato Yellow Dwarf**; **Mosaic**, unidentified.
Powdery mildew is commonly present.

GOLDEN-LARCH (*Pseudolarix*)

CANKER. **Dasyscyphus willkommii**, MA.

GOLDENRAIN-TREE (*Koelreuteria*)

CANKER. **Nectria cinnabarina**, CA, CT.
LEAF SPOT. **Cercospora** sp., FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
WILT. **Verticillium** sp., NJ.

GOLDENROD (*Solidago*)

BLACK KNOT. **Gibberidea heliopsidis**, CT, MO, NY, ND.
BLIGHT, Thread. **Pellicularia koleroga**, LA.
CANKER, Stem. **Botryosphaeria ribis**, IA.
DODDER. **Cuscuta** spp., occasional.
DOWNY MILDEW. **Basidiophora entospora**, IL, WI; **Plasmopara halstedii**, IL, WI.
GALL, Leaf. **Rhodochytrium spilanthidis**, LA.

LEAF SPOT. **Ascochyta compositarum**, WI; **Asteroma solidaginis**, black scurf; **Cercospora parvimaculans**, WI; **Colletotrichum solitarium**, KS, NE, WI; **Macrophoma sphaeropsispora**; **Phyllosticta solidagnicola**, IL, WI; **Placosphaeria haydeni**, black spot; **Ramularia serotina**, CO, IL, TX, WI, WY; **Septoria** spp.

MOLD, Leaf. **Cladosporium astericola**, WI.

NEMATODE, Lesion. **Pratylenchus pratensis**, FL.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Phyllactinia corylea**, WA; **Sphaerotheca macularis**, IN; **Uncinula** sp., NY.

ROT, Root. **Phymatotrichum omnivorum**, TX

RUST. **Coleosporium delicatulum** (II, III), ME to VA, KS; 0, I on pine; **C. asterum** (II, III), general; 0, I on 2- and 3-needle pines; **Puccinia dioicae** (0, I), general; II, III on *Carex*; **Puccinia virgae-aureae** (III), IL, NH, MA, MI, NY; **P. grindeliae** (III), IL, WI to CA, WA; **P. stipae** (0, I), CO, MT, NE, NM, ND; II, III on *Stipa*; **Uromyces perigynius** (0, I), ME; II, III on *Carex*; **U. solidaginis** (III), CO, ID.

SMUT, Inflorescence. **Thecaphora cuneata**, KS.

SPOT ANTHRACNOSE. **Elsinoë solidaginis**, FL, GA, SC.

VIRUS. **Mosaic**. Unidentified, NY; **Tomato Spotted Wilt**, PA.

GOLDENSEAL (*Hydrastis*)

BLIGHT, Leaf. **Alternaria** sp., MI, NY, OH; **Botrytis** sp., CT to NC, IN, WA, WI.

NEMATODE, Root Knot. **Meloidogyne** spp., OH, MI, WA.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, NC.

ROT, Stem. **Phytophthora cactorum**, NC.

VIRUS. **Mosaic**. Unidentified, CT.

WILT. **Fusarium** sp., IL, NY, OH, WA.

GOLDENTOP (*Lamarckia*)

RUST. **Puccinia coronata** (II, III), CA; **P. graminis**, CA.

VIRUS. **Mosaic**, IA.

GOLDTHREAD (*Coptis*)

LEAF SPOT. **Mycosphaerella coptis**, ME, NY, VT; **Septoria coptidis**, ID, MI, NY, VT, WI, WA; **Phyllosticta helleboricola** var. **coptidis**, AK; **Vermicularia coptina**, NY.

GOPHER PLANT or CAPER SPURGE (*Euphorbia*)

ROT, Root. **Macrophomina phaseolina**, AZ; **Pythium aphanidermatum**, AZ; **Rhizoctonia solani**, AZ.

GOOSEBERRY (*Ribes*)

ANTHRACNOSE. **Pseudopeziza ribis**, general.

BLIGHT, Cane. **Botryosphaeria ribis**, NJ, VA; **Leptosphaeria coniothyrium**, IN, MO.

BLIGHT, Thread. **Pellicularia koleroga**, FL.

CANKER; DIEBACK. **Nectria cinnabarina**, coral spot; **Botrytis cinerea**, CT, OR, WA; **Phragmodothella ribesia**, twig knot; **Physalospora obtusa**, NY to VA, KS.

DODDER, **Cuscuta** sp., MN, NY.

DOWNY MILDEW. **Plasmopara ribicola**, MT, OR, WV, WI.

LEAF SPOT. **Marssonina grossulariae**, OH, WI; **Cercospora angulata**, NY to MI, MO; **Mycosphaerella ribis**, MA to VA, AL, KS, MN, OR; **Phyllosticta grossulariae**, CT, NJ, WA, WI; **Ramularia** sp., MI.

NEMATODE, Leaf, Bud. **Aphelenchoides ritzemabosi**, CA.

NONPARASITIC. **Leaf Blotch**. Magnesium deficiency, OR.
Leaf Scorch. Potassium deficiency.

POWDERY MILDEW. **Sphaerotheca macularis**, MN; **S. mors-uvae**, general; **Microsphaera grossulariae**, CA; **Phyllactinia corylea**, NY.

ROT, Root. **Armillaria mellea**, OR, WA; **Dematophora** sp.; **Xylaria hypoxylon**, OR; **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia caricina** var. **grossulariata** (0, I) leaves, fruit, ME to MD, AK, ID, KS, MS, II, III on *Carex*; **P. caricina** var. **uniporula**, IA, MD, NY, WI; **Coleosporium jonesii** (II, III), CO, MO, MN, NM, WI, WY; **Cronartium occidentale**, AZ, CO, UT; **C. ribicola**, white pine blister rust (II, III) – European varieties are resistant.

SPOT ANTHRACNOSE, Scab. **Sphaceloma ribis**, WA.
VIRUS. **Mosaic**. Unidentified, IL, NY.
Powdery mildew caused by *Sphaerotheca mors-uvae* is probably the most important gooseberry disease but is readily controlled by a lime-sulfur spray immediately after bloom, followed by bordeaux mixture spray for leaf spots.

GORDONIA (Franklinia and Loblolly-Bay)

BLACK MILDEW, **Meliola cryptocarpa**, FL, LA.
LEAF SPOT. **Phyllosticta gordoniae**, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.

GOUANIA

RUST. **Puccinia invaginata** (II, III), FL.

GOURD (*Lagenaria, Luffa, Trichosanthes*)

ANTHRACNOSE. **Colletotrichum lagenarium**, CT, IL, IN, IA, MD, MN, NE, PA.
BACTERIAL, Angular Leaf Spot. **Pseudomonas lachrymans**, WI.
BLIGHT, Thread. **Pellicularia koleroga**, FL.
DOWNY MILDEW. **Pseudoperonospora cubensis**, CT, FL, MA, NC, OH.
FRUIT SPOT. **Macrophoma trichosanthis**, AL; **Phoma subvelata**, TX; **Stemphylium** sp., NY.
LEAF SPOT. **Cercospora cucurbitae**, AL, IN.
NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL, OH.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CT, WI.
ROT, Fruit. **Mycosphaerella citrullina** (*Laestadia cucurbitacearum*), PA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Cucumber Mosaic**, IN, NY.
VIRUS. **Tobacco Ring Spot**, TX, on *Luffa acutangula*.

GRAPE (*Vitis*)

ANTRACNOSE. **Elsinoë ampelina**, MI.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, widespread.

BACTERIAL Leaf Spot. **Xanthomonas** sp., NY.
BACTERIAL, Melting, Decay. **Bacillus subtilis**, CA; **Cryptococcus laurentii**, CA.
BACTERIAL, Xylem-limited. **Pierce's Disease**, NC.
BLACK GOO. **Phaeoacremonium chlamydosporum**, CA.
BLACK LEG. **Cylindrocarpon obtusisporum**, CA.
BLIGHT, Shoot. **Sclerotinia sclerotiorum**, CA.
BLOTCH, Leaf. **Briosia amphelophaga**, TX.
CANKER; Deadarm; Branch Necrosis. **Cryptosporella** (*Phomopsis*) **viticola**, widespread; **Aspergillus niger**, CA.
CANKER; Dieback. **Botryosphaeria rhodina** and **B. obtusa**, Baja, Mexico.
CANKER, Wedge-shaped. **Botryosphaeria** sp., CA.
DECLINE. **Phaeoacremonium aleophilum**; **P. chlamydosporum**, NY, PA; **P. inflatipes**, CA.
DIEBACK. **Eutypa armeniacae**, CA, NY; **E. lata**, CA, MI; **Eutypella vitis**, MI.
DOWNY MILDEW. **Plasmopara viticola**, general, serious in East.
FRUIT SPOT; Fly Speck. **Leptothyrium pomi**, PA, WV.
LEAF SPOT. **Mycosphaerella personata** (*Isariopsis clavispora*) widespread **Phomopsis viticola**, NY; **Septoria ampelina**, NY, TX, VA; **Septosporium heterosporum**, CA.
LEAF SPOT, Zonate. **Cristulariella pyramidalis**, WV; **C. moricola**, GA.
MEASLES. **Togninia fraxinopennsylvanica** Anamorph, **Phaeoacremonium viticola**, CA.
NEMATODE. **Meloidoderita** sp., NY.
NEMATODE, Citrus. **Tylenchulus semipenetrans**, CA.
NEMATODE, Cyst. **Heterodera punctata**, MI.
NEMATODE, Dagger. **Xiphinema index**.
NEMATODE, Lesion. **Pratylenchus pratensis**, CA; **P. minyus**, CA; **P. coffeae**, CA; **P. vulnus**, CA.
NEMATODE, Pin. **Paratylenchus hamatus**.
NEMATODE, Ring. **Criconemoides xenoplax**, CA.
NEMATODE, Root Knot. **Meloidogyne** spp.
NEMATODE, Spiral. **Helicotylenchus pseudorobustus**, CA.
NEMATODE, Stubby Root. **Paratrichodorus christiei**.
NONPARASITIC. **Little Leaf**. Zinc deficiency, CA.
Shot Berry. Defective pollination.
Skin Blanching. Sulfur dioxide injury.

POWDERY MILDEW. **Uncinula necator**, general.
ROT, Bitter. **Greeneria uvicola**, MS; **Melanconium fuligineum**, widespread, often secondary after black rot.
ROT, Black. **Guignardia bidwellii**, general.
ROT, Charcoal. **Macrophomina phaseoli**, TX.
ROT, Fruit. **Alternaria** sp., CA; **Aspergillus niger**, black mold, CA, OR; **Botrytis cinerea**, gray mold, CA; **Cladosporium** sp., green mold; **Penicillium** spp., blue mold, cosmopolitan; **Glomerella cingulata**; **Colletotrichum acutatum**; **C. gloeosporioides**, ripe rot; **Pestalotia** sp., **Phoma** spp.; **Botryosphaeria dothidea**, **Macrophoma** rot, MS; **Monilinia fructicola**, brown rot, British Colombia, Canada.
ROT, Root. **Armillaria mellea**, AR, CA, MO, TX, WA; **Phymatotrichum omnivorum**, TX; **Clitocybe tabescens**, SC to TX, OK; **Roesleria hypogaea**, NY to VA, IA, MO; **Rosellinia necatrix**, AL, IN, MI, NY, OH.
ROT, Summer Bunch. **Diplodia viticola** (*D. natalensis*).
ROT, White; Dieback. **Coniothyrium diplodiella**, MA to FL, TX.
ROT, Wood. **Schizophyllum commune**, VA; **Stereum** spp.; **Poria** spp.; **Polyporus** spp.; **Pleurotus ostreatus**, CA.
RUST. **Physopella ampelopsidis** (*P. vitis*) (II), FL, SC.
SCORCH, Leaf. **Pseudopezicula tetraspora**, NY, PA.
SPOT ANTHRACNOSE; Bird's Eye Rot. **Elsinoë ampelina**, widespread.
VIRUS. **Alfalfa Dwarf**; **Grape Fanleaf**; **Grape Leaf Roll** (White Emperor Disease), CA; **Grape Yellow Mosaic**; **Virus Complex** (Kober Stem Grooving), CA.
VIRUS. **Leafroll Disease**. WA.
VIRUS. **Tobacco Ring Spot**, MI, NY; **Tomato Ring Spot**, NY; **Grapevine Fleck**; **Grapevine Stem Pitting** Associated, CA; **Peach Rosette Mosaic**; **Tomato Spotted Wilt**; **Grapevine Rupestris Vein Feathering**, CA.

Black rot is the most destructive grape disease in most sections of the country, often causing total loss of fruit in home gardens. Pierce's disease has destroyed many vineyards in California, the pathogen is transmitted by grafting and by leafhoppers.

GRAPEFRUIT

► Citrus Diseases.

GRAPE-HYACINTH (*Muscari*)

ROT, Dry. **Sclerotium** sp., MO, WA.
SMUT, Flower. **Ustilago vaillantii**, MA, WA.

GRASSES, LAWN, TURF

(Includes *Agropyron repens*, quackgrass; *Agrostis alba*, redtop; *A. canina, A. palustris, A. stolonifera, A. tenuis*, bentgrasses; *Cynodon dactylon*, Bermuda grass; Buffalograss; Bromegrass; *Festuca* spp., fescues; *Poa compressa*, *P. pratensis* and *P. annua*. Canada, Kentucky and annual bluegrasses; *Stenotaphrum*, St. Augustine grass; *Dactylis glomerata*, orchardgrass; *Lolium multiflorum*, Italian ryegrass; *L. perenne*, Perennial ryegrass; *Ammophila breviligulata*, American beachgrass; *Imperata cylindrica*, Cogangrass)

ANTHRACNOSE. **Colletotrichum graminicolum**, general.

BACTERIAL Blight. **Pseudomonas syringae** pv. **coronafaciens**, AK; **P. syringae** pv. **alisalensis** on brome, oat, and common timothy grasses, CA; **Xanthomonas translucens** pv. **poae**, MT; **X. translucens** pv. **cerealis**, ID.

BACTERIAL Gummosis. **Rathayibacter rathayi**, MD, OR, Northeast and Mid-Atlantic U.S.

BACTERIAL Stunting. **Clavibacter xyli** subsp. **cynodontis**, FL.

BACTERIAL, Xylem-limited. **Rickettsialike organism**, MI.

BLIGHT, Dieback (on Johnsongrass, **Sorghum halepense**; Yellow Foxtail, **Setaria glauca**; Broadleaf Signalgrass, **Brachiaria platyphylla**. **Bipolaris cyanodontis**, Southeast U.S.; **Curvularia lunata**, Southeast U.S.; **C. geniculata**, Southeast U.S.; **Exserohilum rostratum**, Southeast U.S.

BLIGHT. **Fusarium roseum** f. sp. **cerealis**, MD, NJ, NY, OH, PA; **F. tricinctum** f. sp. **poae**; **Leptosphaeria korrae**, CA, NJ, NY, and **Phialophora graminicola**, CA, NJ, NY. (New identification for Fusarium Blight); **Limonomyces roseipellis**, NC; **Labyrinthula** sp., AZ.

BLIGHT, Cottony. **Pythium aphanidermatum**, general.

BLIGHT, Leaf. **Pyricularia grisea**, on bent and St. Augustine; **Pellicularia filamentosa** f. sp. **sasakii**; **Drechslera catenaria**, OH; **Rhizoctonia solani**, FL; **Penicillium oxalicum**, NC.

BLIGHT, Melting Out. **Curvularia geniculata**; **C. inaequalis**; **C. lunata**; **Sclerotinia homoeocarpa**, MS.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, IL, NJ.

BLIGHT (Zonate Leaf Spot). **Drechslera gigantea** (*Helminthosporium gigantea*), RI; **Bipolaris sorokiniana**, Southeast, U.S.

BLOTCH, Purple leaf. **Septoria macropoda**; **S. agropyrina**, brown; **S. elymi**, northern U.S.

CHOKE. **Epichloe typhina**, OR.

DAMPING-OFF. **Cladochytrium graminis**, on bentgrass.

DEAD SPOT. **Ophiosphaerella agrostis**, MD, Ontario, Canada.

DODDER. **Cuscuta** sp., MO.

DOLLAR SPOT. **Sclerotinia homoeocarpa**, IL, NY, PA, WA.

DOWNY MILDEW. **Sclerophthora macrospora**, IL, LA, MS, TX, on St. Augustine grass and Kentucky bluegrass.

DOWNY MILDEW. **Sclerospora farlowii**, OK, on Bermuda grass.

ERGOT. **Claviceps purpurea**, NY to KY, MT, ND, TX, OK, OR, WI; **C. microcephala**, MD, MI, OH; **C. cynodontis**, OK.

FAIRY RING. **Marasmius oreades**; **Psalliota campestris**; **Lepiota morgani**; **Cyathus stercoreus** (birds nest fungus), MN.

HONEYDEW. **Claviceps purpurea**, OK.

LEAF SPOT. **Ascochyta agropyrina**, Northwest; **A. desmazieri**; CA, OR, WA; **A. elymi**; **A. graminae** on Bermuda grass; **A. hordei**; **A. sorghi**; **A. graminicola**; **A. utahensis**; **Cercospora seminalis**, TX; **C. fuscomaculans**; **C. poagena**; **Cylindrosporium glyceriae**, NY; **Leptosphaeria korrae**, ringspot, MD, PA, WI; **Macrophoma** sp., OR; **Ovularia pulchella**, OR, UT; **Phaeoseptoria** sp., OR; **Placosphaeria graminis**; **Septogloeum oxysporum**, char spot, widespread; **Stagonospora intermixta**; **Pithomyces chartarum**, NE; **Bipolaris hawaiiensis**, MS.

LEAF SPOT, Black, Tar. **Phyllachora graminis**, widespread; **P. sylvatica**, Northwest.

LEAF SPOT, Brown Stripe. **Scolecotrichum graminis**, widespread, except on ryegrass.

LEAF SPOT, Copper. **Ramulispora** (*Gloeocercospora*) **sorghi**, CA, LA, PA, RI, on bentgrass.

LEAF SPOT, Frog-eye. **Selenophoma donacis**, northern states; **S. everhartii**; **S. obtusa**.

LEAF SPOT, Gray. **Pyricularia grisea**, blast disease, CA, CT, IL, IN, ME, MA, NH, PA, RI; **P. perenne** (on ryegrass), NV.

LEAF SPOT, Gray Leaf Speckle. **Septoria triseti**, OR, WA on redtop, bent; **S. calamagrostidis**, AK, OR, WY; **S. loligena**, CA; **S. nodorum**; **S. oudemansii**, northern U.S.; **S. secalis**, white leaf spot; **S. tenella**, northern plains; **S. tritici** var. **lolicola**.

LEAF SPOT, Melting-out. **Helminthosporium vagans**, on bluegrass; **H. sativum**; **H. giganteum**, Zonate eye-spot, general; **H. dictyoides**, fescue netblotch; **H. siccans**, brown blight; **H. stenacrum**, leaf mold; **H. triseptatum**, gray leaf mold; **H. cynodontis**, Bermuda grass leaf blotch; **H. erythrospilum**; **H. rostratum**; **H. stenophilum**.

LEAF SPOT, Red Eye-Spot. **Mastigosporium rubricosum**, ME, OR, WA, WY.

LEAF SPOT, Yellow Ring. **Trechispora alnicola**, IL.

MOLD. **Cladosporium herbarum**; **Fusarium heterosporum**.

NEMATODE, Barley Root Knot, **Meloidogyne naasi**, Quebec, Canada.

NEMATODE, Cyst. **Punctodera punctata**, NJ; **Heterodera iri**, CT, ME, MA, NH, NY, RI.

NEMATODE, Dagger. **Xiphinema americanum**.

NEMATODE, Gall. **Anguina agrostis**.

NEMATODE, Lance. **Hoplolaimus coronatus**.

NEMATODE, Lesion. **Pratylenchus brachyurus**; **P. pratensis**; **P. subpenetrans**; **P. thornei**; **P. fallax**.

NEMATODE, Pin. **Paratylenchus projectus**.

NEMATODE, Pseudo Root Knot. **Hypsoperine graminis**, AL, MD, TN.

NEMATODE, Ring. **Criconemoides lobatum**; **C. rusticum**, **C. xenoplax**, **C. ornatum**, **C. parvum**, **C. curvatum**, OH; **Criconemella xenoplax**, SC.

NEMATODE, Root Knot. **Meloidogyne** sp.; **M. incognita**; **Subanguina radicicola**, New Brunswick, Canada.

NEMATODE, Seed Gall. **Anguina agrostis**, MN, VA.

NEMATODE, Spiral. **Helicotylenchus nannus**; **H. dihystera**; **Rotylenchus cristiei**, FL.

NEMATODE, Sting. **Belonolaimus gracilis**; **B. longicaudatus**, CA.

NEMATODE, Stubby Root. **Paratrichodorus christiei**; **P. obtusa**.

NEMATODE, Stylet. **Tylenchorhynchus brevidus**; **T. claytoni**; **T. dubius**.

NONPARASITIC. **Burn**. Mowing too close in hot weather.

Spring Dead Spot. Too much thatch.

PATCH, SUMMER. **Magnaporthe poae**, Oh.

POWDERY MILDEW. **Erysiphe graminis**, general.

ROT, BLIND SEED. **Gloeotinia temulenta**, OR.

ROT, Crown. **Drechslera catenaria**, OH.

ROT, Culm. **Fusarium culmorum**; **Gibberella zeae**.

ROT; Dollar Spot; Small Brown Patch. **Sclerotinia homoeocarpa**, general.

ROT, Foot. **Ophiobolus graminis**, NY, WA.

ROT; Large Brown Patch. **Pellicularia filamentosa** (*Rhizoctonia solani*); widespread, more important on bentgrass than on bluegrass; **Magnaporthe poae**, FL, NC; **Ophiosphaerella agrostis**, FL, MD, MA, MS, MO, NC, OH, TX, VA (eastern seaboard).

ROT; Pink Patch; Red Thread. **Corticium fuciforme**, general.

ROT, Root. **Pythium debaryanum**; **P. arrhenomanes**, LA; **P. ultimum**; **Fusarium** spp.; **Olpidium brassicae**; **Pyrenochaeta terrestris**, IL; crown and root, **Ophiosphaerella agrostis**, TX; **Gaeumannomyces graminis** var. **graminis**, MS.

RUST. **Puccinia graminis** subsp. **graminicola**, OR; **Puccinia pygmaea**, NY; **Uromyces mysticus** (II, III), OR; **U. dactylidis**, IN, MI, SD, VI.

RUST, Bluegrass. **Puccinia poae-nemoralis**, widespread; **P. recondita** on bromegrass, PA; **P. striiformis**, stripe rust, OR; **P. cynodontis**, on Bermuda grass; **P. stenotaphri**, on St. Augustine grass; **P. piperi**.

RUST, Crown. **Puccinia coronata** (II, III), cosmopolitan; **P. glumarum**.

RUST, Stem; Wheat. **Puccinia graminis**, cosmopolitan.

SCAB. **Fusarium heterosporum**, MO.

SLIME MOLD. **Mucilago spongiosa**; **Physarum cinereum**; **Fuligo septica**.

SMUT, Bluegrass Blister. **Entyloma irregulare** and other spp.

SMUT, Flag. **Urocystis agropyri**, OH, WI.

SMUT, Head; Bunt. **Tilletia pallida**, NJ, OH, OR; **T. fusca**; **T. buchloëana**, KS, NE, OK, TX.

SMUT, Inflorescence. **Sorosporium syntherisme**, CA.

SMUT, Stripe. **Ustilago striiformis**, widespread; **U. cynodontis** on Bermuda grass in South; **U. buchloes**, TX.

SNOWMOLD, Blight. **Fusarium nivale**, AK, MI, MN, OR, WA; **Calonectria graminicola**; **Sclerotinia borealis**, AK; **Sclerotium rhizodes**, white tip, CT, MA, NJ, PA, WI; **Typhula itoana**, MA, MN, NJ, NY, PA; **T. idahoensis**, ID.

SPRING DEAD SPOT. **Gaeumannomyces graminis** var. **graminis**, AL, FL, NC, TX; **Ophiosphaerella herpotricha**; **O. korrae**; **O. narmari**, KS, OK.

STEM EYESPOT. **Phloeospora idahoensis**, OH.
SYMBIOTIC ENDOPHYTE. **Acremonium typhinum**, NJ.
VIRUS. **Bromegrass Mosaic**. General, IA, IL; **Clover Yellow Vein**, GA; **Maize Dwarf Mosaic**; **Peanut Mottle**, GA; **St. Augustine Decline Virus** (**Panicum Mosaic**), AR, LA, TX; **Sugarcane Mosaic**, FL; **Barley Yellow Dwarf**, IN, MO; **Cocksfoot Streak**; **Agropyron Mosaic**; **Grapvine Fanleaf**, CA; **Lolium Latent**, MD.

The possibility of any large proportion of these diseases appearing in the average suburban lawn is remote. Snowmold occurs occasionally after a winter when the snow cover has been rather continuous, but the light tan areas disappear by late spring. Large brown patch is fairly general in humid summer weather along with dollar spot, and Helminthosporium leaf spots or melting-out. Merion bluegrass is resistant to the latter but not to bluegrass rust. *Acremonium* sp. first *Clavicipitaceous* endophyte of perennial ryegrass (*Lolium perenne*) caused a hyperthermia syndrome of cattle, TX, WA.

GRASS-OF-PARNASSUS (*Parnassia*)

POWDERY MILDEW. **Erysiphe polygoni**, NY.
RUST. **Puccinia parnassiae** (III), UT; **P. caricina** var. **uliginosa**, (I), AK; II, III on *Carex*.

GREVILLEA (Silk-Oak)

DIEBACK; Gum Disease. **Diplodia** sp. (*Physalospora rhodina*), FL.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
ROT, Root. **Phymatotrichum omnivorum**, AZ.

GRINDELIA (Gumweed)

LEAF SPOT. **Cercospora grindeliae**, CA, TX, WI; **Septoria grindeliae**, CO, KS, TX; **S. grindeliicola**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, MN to NM, CA, MT.
ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Coleosporium asterum** (II, III), CA, CO, WA, WI; 0, I on pine; **Puccinia dioicae** (0, I), KS, NE, TX; II, III on *Carex*; **P. grindeliae** (III), NE to TX, CA, MT; **P. stipae** (0, I), CO, KS, NE, ND, SD; II, III on *Stipa* and other grasses; **Uromyces junci** (0, I); II, III on *Juncus*.

SMUT, Inflorescence. **Thecaphora californica**, CA, UT; **T. Cuneata**, CO, KS, NE, NM.

GROUND-CHERRY, HUSK-TOMATO (*Physalis*)

BACTERIAL Angular Leaf Spot. **Pseudomonas angulata**, KY.

BACTERIAL Canker. Vascular. **Clavibacter michiganense**, WY. Also **Pseudomonas longifolia**.

BACTERIAL, Wildfire. **Pseudomonas syringae** pv. **tabaci**, PA.

BLIGHT, Seedling. **Gloeosporium fructigenum**, NY.

BLIGHT, Southern. **Sclerotium rolfsii**, FL.

LEAF SPOT. **Alternaria solani**; **Cercospora diffusa**, IL, KS, WI; **C. physalicola**, CT to GA, TX; **Leptosphaeria physalidis**, KY; **Phyllosticta** sp., OK; **Septoria** sp., NE; **Stemphylium solani**, FL.

NECROSIS, Vascular. **Verticillium dahliae**, NM.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CA.

NEMATODE, Root Knot. **Meloidogyne** spp., AL, FL.

POWDERY MILDEW. **Sphaerotheca fusca**, CA.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Aecidium physalidis**, WI to TX, CO, NM; **Puccinia physalidis**, CO, IA, MN, NE, WI.

SMUT, White. **Entyloma australe**, MA to MS, NM, ND.

VIRUS. **Beet Curly Top**; **Mosaic** (part cucumber, part tobacco mosaic); **Ring Spot** (Tobacco); **Physalis Mosaic**, IL; **Potato Leafroll**, Pacific Northwest; **Tomato Spotted Wilt**, GA.

GROUND-CHERRY, PURPLE-FLOWERED (*Quincula*)

LEAF SPOT. **Cercospora physalidis**, KS.

RUST. **Puccinia aristidae** (0, I), CO.

GROUND-IVY (*Gleoma*)

RUST. **Puccinia glechomatis**, IN, NY.

GROUNDNUT (*Apios*)

LEAF AND STEM DISEASE. **Cercospora zebrina** (clover isolate), NC.
VIRUS. **Cucumber Mosaic**, LA; **Desmodium Yellow Mottle**, LA.

GROUND-SMOKE (*Gayophytum*)

LEAF SPOT. **Cercospora gayophyti**, CA.
RUST. **Puccinia vagans** (0, I, II, III), ND to NM, CA, WA.
SMUT, Seed. **Ustilago gayophyti**, CA, NV, OR, UT.

GUAR (*Cyamopsis*)

BACTERIAL Blight. **Xanthomonas campestris** pv. **cyamopsidis**, AZ.
POWDERY MILDEW. **Leveillula taurica**, AZ.
VIRUS. **Guar Symptomless**.

GUAVA (*Psidium*)

ANTHRACNOSE; Leaf and Fruit Spot; Ripe Rot. **Glomerella cingulata**,FL.
BLIGHT, Thread. **Pellicularia koleroga**, FL.
LEAF SPOT. **Cercospora psidii**, FL.
LEAF SPOT, Algal; Green Scurf. **Cephaleuros virescens**, FL.
NEMATODE, Burrowing. **Radopholus similis**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Fruit. **Alternaria citri**, CA; **Rhizopus stolonifer**, HI.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
ROT, Wound. **Polyporus versicolor**, FL.
SCAB. **Pestalotiopsis** spp., HI.

GUAYULE (*Parthenium*)

ROT, Root. **Pythium aphanidermatum**, AZ.

GYPSOPHILA (Babys-Breath)

BACTERIAL Fasciation. **Clavibacter fascians**, OH.
BACTERIAL, MLO. **Aster Yellows**, NY, and **California Aster Yellows**, CA.
BACTERIAL Root and Stem Gall. **Erwinia herbicola** (*Agrobacterium gypsophilae*), NJ.
BLIGHT, Gray Mold. **Botrytis cinerea**, NJ.
DAMPING-OFF. **Pythium debaryanum**, CT; **Rhizoctonia solani**, CT.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROOT ROT. **Phytophthora dreschleri**, NC.
WILT. **Phytophthora cactorum**, MA.

HACKBERRY, SUGARBERRY (*Celtis*)

BLIGHT, Leaf. **Cylindrosporium defoliatum**, TX.
BLIGHT, Thread. **Pellicularia koleroga**, FL.
CANKER, Felt Fungus. **Septobasidium burtii**, TX; **S. sydowii**, TX.
DOWNY MILDEW. **Pseudoperonospora celtidis**, GA, MD.
LEAF SPOT. **Cercosporella celtidis**, AL, TX, central states; **Cylindrosporium celtidis**, AL; **Phloeospora celtidis**, MA to TX; **Phyllosticta celtidis**, general; **Septogloeum celtidis**, NY.
MISTLETOE. **Phoradendron tomentosum** and **P. serotinum** (**flavescens**), southeastern and Gulf states.
POWDERY MILDEW. **Sphaerotheca phytoptophila**, associated with gall mites causing witches' brooms, widespread, especially in central states; **Uncinula macrospora**, FL, GA; **U. parvula**, widespread; **U. polychaeta**, in South.
ROT, Root. **Armillaria mellea**, occasional; **Helicobasidium purpureum**, seedling blight, TX; **Phymatotrichum omnivorum**, TX; **Poria ambigua**, TX.
ROT, Wood. **Daedalea** spp.; **Fomes** spp.; **Ganoderma lucidum**; **Polyporus** spp.; **Stereum bicolor**, cosmopolitan.
VIRUS. **Island Chlorosis**, IL; **Hackberry Leaf Mosaic**.
Hackberry witches' brooms, so prominent in a winter landscape, are caused by gall mites in association with powdery mildew. There is no real control, except to cut off unsightly branches. Chinese hackberry and southern hackberry are less susceptible.

HALESIA (Silver-Bell, Snowdrop-Tree)

LEAF SPOT. **Cercospora halesiae**, TN; **Cristulariella moricola**, zonate leaf spot, LA.
ROT, Wood. **Polyporus halesiae**, GA.
Other fungi are reported on twigs and branches but not as causing specific diseases.

HAMELIA (Scarlet-Bush)

ROT, Root. **Clitocybe tabescens**, FL.
RUST. **Uredo hameliae**, FL.

HARBINGER-OF-SPRING (*Erigenia*)

RUST. **Puccinia erigeniae** (0, I, III), OH.

HARDENBERGIA

NEMATODE, Root Knot. **Meloidogyne** sp.

HARDY ORANGE (*Poncirus*)

ANTHRACNOSE; DIEBACK. **Glomerella cingulata**, Gulf states.
CANKER; DIEBACK. **Diaporthe citri**, melanose, Gulf states; **Diplodia natalensis**, gummosis, general.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Xylaria polymorpha**, LA.
SPOT ANTHRACNOSE; Citrus Scab. **Elsinoë fawcettii**, MS.

HARES-TAIL (Lagurus)

RUST. **Puccinia coronata** (II, III), crown; **P. graminis**, stem, WA.

HAWKBIT, FALL DANDELION (*Leontodon*)

BACTERIAL, MLO. **Aster Yellows**, ME, NY.
RUST. **Puccinia hieracii** (0, I, II, III), ME, NH.

HAWKSBEARD (*Crepis*)

LEAF SPOT. **Cercospora stromatis**, CO; **Phyllosticta eximia**, CO; **Ramularia crepidis**, NM.

POWDERY MILDEW. **Golovinomyces cichoracearum**, NE, PA; **Sphaerotheca macularis**, WY.

RUST. **Puccinia crepidis-montanae** (0, I, II, III), CO, ID, MT, OR, UT, WA, WY; **P. hieracii**, ND to CO, WA; II, III on *Carex*.

HAWKWEED (*Hieracium*)

BLIGHT, Stem. **Phoma hieracii**, TX.

DOWNY MILDEW. **Bremia lactucae**, WI.

LEAF SPOT. **Cercospora hieracii**, AL, NC; **Phyllosticta decidua**, WI; **Septoria cercosperma**, TX; **S. hieracicola**, NY.

POWDERY MILDEW. **Golovinomyces cichoracearum**, PA, TX; **Sphaerotheca macularis**, IL.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia dioicae** (0, I), PA to IL, CA, MT, OR, WI; II, III on *Carex*; **P. fraseri** (III), MT, NE, NY, NH, PA, TN, VA, WV; **P. hieracii** (0, I, II, III), ME to VA, CA, CO FL, IL, TX, WA; **P. columbiensis**, OR, TX, WA; **Aecidium columbiense** (0, I), CA, ID, OR, WA.

HAWTHORN (*Crataegus*)

BACTERIAL Fire Blight. **Erwinia amylovora**, widespread, especially on English hawthorn.

BLIGHT, Leaf. **Fabraea thuemenii** (*F. maculata, Entomosporium thuemenii*), East and central states, southward.

BLIGHT, Leaf; Fruit Spot. **Monilinia johnsonii**, NY to MN.

BLIGHT, Seedling. **Sclerotium rolfsii**, FL.

CANKER, Felt Fungus. **Septobasidium** spp., Southeast and Gulf states.

LEAF SPOT. **Cercospora apiifoliae**, TX; **Cercosporella mirabilis**, CO, NY, WI; **Coniothyrium pyrinum**, IL; **Cylindrosporium brevispina**, CA to MT, WA; **C. crataegi**, WA; **Gloeosporium crataegi**, WA; **Hendersonia crataegicola**, AL, TX; **Monochaetia crataegi**, FL; **Phyllosticta** spp., widespread; **Septoria crataegi**, MI to ND; **Mycosphaerella** sp., GA.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
MISTLETOE. **Viscum album**, CA.
POWDERY MILDEW. **Podosphaera oxyacanthae**, East and central states; **Phyllactinia corylea**, general.
ROT, Gray Mold, on fruit. **Botrytis cinerea**, AK.
ROT, Root. **Armillaria mellea**, OK; **Phymatotrichum omnivorum**, TX. **Xylaria digitata**; **X. hypoxylon**, IN, OH.
ROT, Wood. **Daedalea confragosa**, cosmopolitan; **Polyporus versicolor**, cosmopolitan; **Fomes** spp.
RUST. **Gymnosporangium bethelii** (0, I), on fruits; ND to WA, CO, NM; III on juniper; **G. clavipes**, quince rust (0, I), on leaves, fruits, general, east of Rocky Mts.; **G. exiguum**, on leaves, fruits, TX; II, III on juniper; **G. floriforme**, on leaves, SC to FL, OK, TX; III on red-cedar; **G. globosum**, hawthorn rust (0, I) on leaves, ME to ND, FL, TX; II, III on juniper; **G. hyalinum** (0, I), leaves, Atlantic Coast, NC to FL; III unknown; **G. libocedri** (0, I), leaves and fruit, Pacific Coast; III on *Libocedrus*; **G. nelsonii** (0, I), on leaves, fruits, WY; III on juniper; **G. trachysorum** (0, I), on leaves, Atlantic and Gulf coasts; III on red-cedar; **G. tubulatum** (0, I), on leaves, Rocky Mts. to OR and WA.
SCAB. **Venturia inaequalis**, widespread; **V. crataegi**, FL.

Rusts are common on hawthorn and particularly so in the central states, where junipers should be kept at a distance. Leaf blight, beginning in a moist spring, causes spotting and defoliation in August. When branches die back from fire blight, cut them off several inches below the visible blighted portion.

HAZELNUT, FILBERT (*Corylus*)

BACTERIAL Blight. **Xanthomonas corylina**, OR, WA; **Pseudomonas syringae** pv. **coryli**.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, WA.
BACTERIAL Spot. **Pseudomonas colurnae**, IL.
BLIGHT, Eastern Filbert. **Anisogramma anomala**, NY, OR, WA.
CANKER; Twig Blight. **Apioporthe anomala**, eastern and central states; **Hymenochaete agglutinans**, ME; **Gleosporium** sp.
FILBERT STUNT. Undetermined causal agent, OR.
KERNEL SPOT; Yeast Spot. **Nematospora coryli**, OR.
LEAF BLISTER. **Taphrina coryli**, CT, MA, WI.

LEAF SPOT. **Cercospora corylina**, OK; **Cylindrosporium vermiforme**, WI; **Gloeosporium coryli**, ME to NJ, OR, PA, WA; **Phyllosticta coryli**, widespread; **Septogloeum profusum**, IN, MA, MS; **Septoria corylina**, MA to NJ, OR, WA, WI; **Sphaerognomonia carpinea**, GA; **Gnomoniella coryli**, general; **Alternaria arborescens**, **A. alternata**, **A. tenuissima** (leaf spot and brown/gray apical necrosis), AZ.

NONPARASITIC. **Bitter Pit** and **Brown Stain** of nuts. Cause unknown, OR, WA. **Shrivel**, "Blanks." Defective pollination, OR, WA.

POWDERY MILDEW. **Phyllactinia corylea**, northeastern and north central states, OR, WA; **Microsphaera alni**, northeastern and north central states; **P. gutata**, WA.

ROT, Root. **Armillaria mellea**, CA, OR, WA; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Poria ferrea**, CA.

VIRUS. **Apple Mosaic**, OR; **Clover Yellow Edge Phytoplasma**, OR.

Bacterial blight often kills young trees in Washington and Oregon. Powdery mildew is important in the Northwest.

HEATH (*Erica*)

POWDERY MILDEW. **Erysiphe polygoni**, CA.

ROT, Collar. **Phytophthora cinnamomi**, CA, NY.

ROT, Root and Crown. **Cylindrocladium pauciramosum**, CA.

ROT, Stem. **Ascochyta** sp., NJ.

RUST. **Pucciniastrum ericae** (II), CA.

HEATHER (*Calluna*)

NONPARASITIC. **Chlorosis**. Iron deficiency, corrected by spraying with ferrous sulfate.

ROT, Root, Collar. **Phytophthora cinnamomi**, CA, OR.

HEBE

BACTERIAL Fasciation. **Clavibacter fascians**, CA.

LEAF SPOT. **Septoria exotica**, CA.

ROT, Root. **Armillaria mellea**, CA.

WILT. **Fusarium oxysporum** f. sp. **hebae**, CA.

HEDGE PARSLEY (*Torilis*)

GALL, Leaf. **Protomyces macrosporus**, AR.

HELENIUM (Sneezeweed)

BACTERIAL, MLO. **Aster Yellows**, NY, and **California Aster Yellows**, CA.
LEAF SPOT. **Cercospora helenii**, AL, TX; **Septoria helenii**, IA, PA, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CO, OR, TX, UT, WA, WI, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia conspicua** (0, I), AZ, CO, NM; II, III on *Koeleria*, **P. dioicae** (0, I), CO, NE, TX; II, III on *Carex*.
SMUT. **Entyloma compositarum**, TX, WI; **E. polysporum**, MT.
VIRUS. **Helenium S. Carlavirus**.

HELICHRYSUM

► Strawflower.

HELIOPSIS

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.
BLACK KNOT. **Gibberidea heliopsidis**.
LEAF SPOT. **Phyllosticta pitcheriana**, NY; **Septoria helianthi**, IN; **S. heliopsidis**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, IA, MN, NE, NM, ND, WI; **Leveillula taurica**, IA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium helianthi** (II, III), NC; 0, I on pine; **Puccinia batesiana** (0, I, III), DE, IA, KS, MD, MN, NE, PA, WI; **P. helianthi** (0, I, II, III), IN, MN, NC, PA, VA.
VIRUS. **Mosaic**. Unidentified, IA.

HELIOTROPE (*Heliotropium*)

BLIGHT, Shoot; Leaf Spot. **Botrytis cinerea**, cosmopolitan; **Stemphylium** sp., NY.

LEAF SPOT **Cercospora heliotropii**, NM, OR.
NEMATODE, Root Knot. **Meloidogyne** sp., MA, WA.
RUST. **Puccinia aristidae** (0, I), AZ, CA, NV, NM, TX, UT; II, III on grasses.
WILT. **Verticillium albo-atrum**, MD.

HEMLOCK (*Tsuga*)

BLIGHT, Needle. **Didymascella tsugae**, MA, NH, WI; **Rosellinia herpotrichioides**, NC.
BLIGHT Snow. **Herpotrichia nigra**, MT to OR, AK.
BLIGHT, Twig. **Botrytis cinerea**, ID.
CANKER, Bleeding. **Phacidiopycnis pseudotsugae** (*Phacidiella coniferarum*) on eastern hemlock.
CANKER, Branch. **Discocainia treleasi** on western hemlock, AK, WA.
CANKER, Stem Girdle, of saplings. **Hymenochaete agglutinans**, PA.
CANKER Twig. **Cytospora** sp., MD, VA; **Dermatea balsamea**, GA, NY, TN, VA.
DAMPING-OFF. **Rhizoctonia solani**, cosmopolitan.
MISTLETOE, Dwarf. **Arceuthobium campylopodium**, AK, ID; **A. cyanocarpum**, OR; **A. tsugense**, AK; **A. laricis**, WA; **A. abietinum**, OR.
NONPARASITIC. **Canker**; Bark Split. Heavy soil and poor drainage.
ROT, Root. **Armillaria mellea**, MA to PA, MI, OR, WA; **Phymatotrichum omnivorum**, TX; **Fusarium solani**, PA; **F. oxysporum**, PA; **F. avenaceum**, PA; **Phytophthora citricola**, NC.
ROT, Seedling Root. **Cylindrocladium scoparium**, NY; **Rhizina undulata**, NY.
ROT, Wood. **Fomes** spp.; **Ganoderma lucidum**, Northeast; **Polyporus** spp., general.
RUST, Needle, Cone. **Caeoma dubium** (0, I), ID, MT, OR, WA; **Melampsora abietis-canadensis** (0, I), New England to PA; II, III on poplar; **M. farlowii** (III), New England to NC, WI; **Pucciniastrum hydrangeae** (0, I), IN, MD, PA, TN; II, III on hydrangea; **P. myrtilli** (0, I), ME to AL, IN, WI; II, III on *Ericaceae*; **Uraecium holwayi** (0, I), AK, MT, OR, WA; **Thekopsora minima**.

HEMP (*Cannabis*)

BLIGHT, Gray Mold. **Botrytis cinerea**, OR, VA.
BLIGHT, Southern. **Sclerotium rolfsii**, SC, TX.
BROOMRAPE. **Orobanche ramosa**, CA, IL, KY, WI.
CANKER, **Sclerotinia sclerotiorum**, Canada.
CANKER; Stem Rot. **Gibberella quinqueseptata**; **G. saubinetti**, IN, VA.
CANKER; Stem Wilt. **Botryosphaeria marconii**, MD, VA.
LEAF CURL, Wilt. **Cercospora cannabina**, MS.
LEAF SPOT. **Cylindrosporium** spp., MD; **Septoria cannabis**, MD to KY, FL, IA, MN, TX; **Cercospora cannabis**, MS.
NEMATODE, Root Knot. **Meloidogyne** sp., TN.
ROT, Charcoal. **Macrophomina phaseoli**, IL.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Hypomyces cancri**, MD.
ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, MT.

HEMPSESBANIA (*Sesbania*)

CANKER, STEM. **Diaporthe phaseolorum** var. **caulivora**, LA.

HENBIT (*Laminum*)

ROT. **Sclerotinia minor**, NC.
VIRUS. **Tomato Ringspot**, PA.

HEPATICA

DOWNY MILDEW. **Plasmopara pygmaea**, IA, IL, NY, PA, WI.
LEAF SPOT. **Discosia artocreas**, secondary, IA; **Septoria hepaticae**, MI, NC.
RUST. **Tranzschelia pruni-spinosae** (0, I), MA to MD, TN, MN; II, III on wild plum.
SMUT, Leaf and Stem. **Urocystis anemones**, NY to IN, MO, MN, WI.

HERACLEUM (Cow-Parsnip)

LEAF SPOT. **Cylindrosporium heraclei**, CA, CO, ID, MT, ND, TX, UT, WA, WY; **Fusicladium angelicae**, WI; **Phyllosticta heraclei**, AK, OR, TX; **Ramularia heraclei**, general.
ROT, Root. **Phymatotrichum omnivorum**, TX.

HERCULES-CLUB (*Aralia spinosa*)

CANKER; DIEBACK. **Botryosphaeria ribis**, GA, VA, WV; **Nectria cinnabarina**, VA, WV.
LEAF SPOT. **Cercospora atromaculans**, LA, TX; **Phyllosticta araliae**, TX; **P. everhartii**, TX, WV; **Stagonospora** sp., WV.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX.
ROT, Sapwood. **Polyporus tulipiferae**, MD.
SPOT ANTHRACNOSE. **Sphaceloma araliae**, MD, MO.

HERCULES-CLUB (*Zanthoxylum clava-herculis*)

LEAF SPOT. **Cercospora xanthoxyli**, FL, GA, TX; **Septoria pachyspora**, TX.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
RUST. **Puccinia andropogonis** var. **xanthoxyli** (0, I) FL, TX: II, III on *Andropogon*.

HERONSBILL (*Erodium*)

BACTERIAL, MLO. **California Aster Yellows**.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
DOWNY MILDEW. **Pseudoperonospora erodii**, MT, TX.
GALL, Leaf. **Synchytrium papillatum**, AZ, CA, OR, TX.
ROT, Root. **Rhizoctonia solani**, TX.
VIRUS. **Beet Curly Top**, CA; **Filaree Red Leaf**, CA.

HESPERIS (Dames-Rocket)

CLUB ROOT. **Plasmodiophora brassicae**, NJ.
DOWNY MILDEW. **Peronospora parasitica**, NY, PA.

VIRUS. **Cucumber Mosaic**, OR.
WHITE RUST; White Blister. **Albugo candida**, NY.

HEUCHERA (Alum-Root, Coral-Bells)

LEAF SPOT. **Cercospora heucherae**, IL, IN, IA, OH, PA, VA, WV, WI; **Phyllosticta excavata**, AK, ID; **Ramularia mitellae** var. **heucherae**, WA; **Septoria heucherae**, IN.
LEAF NEMATODE. **Aphelenchoides fragariae**, CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA; **Sphaerotheca macularis**, MT, NM; **Phyllactinia corylea**, MT.
ROT, Root. **Phytophthora cinnamomi**, NC; **Pythium hypogynum** and **P. ultimum**.
RUST. **Puccinia heucherae** (III), PA to NC, AK, SD; western states.
SMUT, Leaf and Stem. **Urocystis lithophragmae**, UT.
VIRUS. Tobacco Rattle, MA, MI, MN.

HIBBERTIA (Guinea-Gold-Vine)

VIRUS. **Cucumber Mosaic**, CA, SC.

HIBISCUS (Arborescent Forms) (Rose-of-Sharon, Confederate-Rose, Chinese Hibiscus, Kenaf)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MS.
BACTERIAL Leaf Spot. **Pseudomonas syringae**, CA, FL; **P. syringae** pv. **hibisci**, FL; **Xanthomonas campestris** pv. **malvacearum**, FL.
BACTERIAL Wilt. **Xanthomonas solanacearum**, FL.
BLIGHT, Blossom. **Choanephora infundibulifera**, FL.
BLIGHT, Leaf Stem. **Phytophthora palmivora**, LA; **P. parasitica**, FL.
BLIGHT, Thread. **Pellicularia koleroga**, FL; web, **P. filamentosa**, FL.
CANKER; DIEBACK. **Colletotrichum hibisci**, FL, TX.
LEAF SPOT. **Alternaria tenuis**, IN, NJ, PA; **Cercospora hibisci**, FL, OK, TX; **C. amalayensis**, GA; **Phyllosticta hibiscina**, LA; **Cristulariella pyramidalis**, FL, GA, MD, MS; **C. moricola**, LA.
NEMATODE, Leaf. **Aphelenchoides fragariae**, FL.
NEMATODE, Root Knot. **Meloidogyne** spp., MS, TX.

NONPARASITIC. **Strapleaf**. Molybdenum deficiency, FL.
POWDERY MILDEW. **Leveillula taurica**, TX.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Fusarium** sp., FL; **Phytophthora parasitica**, TX; **P. cactorum**, LA; **P. palmivora**, LA.
RUST. **Kuehneola malvicola** (II, III), Gulf states.
STUNTING. **Hoplolaimus magnistylus**, MS.
VIRUS. **Mosaic**, unidentified, FL; **Hibiscus Chlorotic Ringspot**; **Tomato Spotted Wilt**, TX; **Potato Leaf Roll**, Pacific Northwest; **Hibiscus Latent Fort Pierce**, NM.

HICKORY (*Carya*)

ANTHRACNOSE; Leaf Spot. **Gnomonia caryae**, general (see under Leaf Spots).
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, KS, MD, TX.
BLOTCH, Leaf. **Mycosphaerella dendroides**, widespread East and South.
CANKER. **Nectria galligena**, eastern states; **Strumella coryneoidea**, MD, PA.
CANKER, Bark Patch. **Aleurodiscus candidus**, MO, OH, PA; **Solenia ochracea**, MA.
CANKER, Felt Fungus. **Septobasidium** spp., Southeast.
CANKER, Heart Rot. **Poria spiculosa**, destructive to pignut, shagbark, PA, and South.
CANKER, Twig. **Rosellinia caryae**, MI; **Botryosphaeria berengeriana**.
GALL, Trunk, Branch. **Phomopsis** sp., eastern states.
LEAF SPOT. **Fusarium carpineum**, WI; **Hendersonia davisii**, WI; **Marssonina juglandis** (*Gnomonia leptostyla*), NJ, NC to IA; **Microstroma juglandis**, witches' broom; **Monochaetia desmazierii**, MD to NC, TN; **Mycosphaerella carigena**, WI; **Pestalotia sphaerelloides**, LA; **Phyllosticta caryae**, widespread; **Septoria caryae**, DE, MI; **S. hicoriae**, TX; **Cercospora fusca**.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), IN, TX; **Viscum album**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp.
NONPARASITIC. **Rosette**. Zinc deficiency, southern states.
POWDERY MILDEW. **Phyllactinia corylea**, MI, WI; **Microsphaera alni**, cosmopolitan.

ROT, Heart. **Favolus alveolaris**, NY, VT, VA; **Fomes** spp., cosmopolitan.
ROT, Root. **Armillaria mellea**, cosmopolitan; **Clitocybe parasitica**, OK; **Phymatotrichum omnivorum** AZ, TX; **Helicobasidium purpureum**.
ROT, Wood. **Daedalea** spp.; **Ganoderma curtisii**; **Polyporus** spp.; **Stecherinum septentrionale**; **Schizophyllum commune**; **Stereum hirsutum**; **Trametes rigida**.
SCAB; Leaf Spot. **Cladosporium effusum**, general.
SPOT ANTHRACNOSE. **Elsinoë randii**.
WILT. **Verticillium** sp., VA.
Of the various leaf spots on hickory, anthracnose caused by *Gnomonia caryae* is the most destructive. There are no recommended control measures for witches' brooms appearing on shagbark hickory except cutting them out.

HIPPEASTRUM

► Amaryllis.

HOARHOUND (*Marrubium*)

GALL, Leaf. **Synchytrium marrubii**, TX.
LEAF SPOT. **Cercospora marrubii**, OK, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., AL.

HOARY-TICK CLOVER (*Desmodium*)

ROT, BLACK. **Cylindrocladium parasiticum**, FL.
VIRUS. **Cowpea Mosaic**, IL; **Desmodium Mosaic**, FL; **Desmodium Yellow Mottle**, AR.

HOLLY (*Ilex*) (*Ilex opaca*, American; *I. equifolium*, English; *I. cornuta*, Chinese; *I. crenata*, Japanese)

BACTERIAL Blight. **Clavibacter ilicis**, MA.
BLACK MILDEW. **Asterina** (*Englerulaster*) **orbicularis**, DE to FL, TX; **A. ilicis**; **A. pelliculosa**; **Morenoella** (*Lembosia*) **ilicis**, Gulf states.
BLIGHT, Flower. **Botrytis cinerea**, NJ.
BLIGHT, Leaf and Twig. **Phytophthora ilicis**, OR, WA.

BLIGHT, Thread. **Pellicularia koleroga**, LA; silky thread, **Rhizoctonia ramicola**; web, **Cylindrocladium scoparium**, AL.

CANKER; DIEBACK. **Boydia insculpta**, secondary, OR, WA; **Diaporthe eres**, secondary; **Diplodia** sp., MD; **Nectria coccinea**; **Phomopsis** sp.; **Physalospora ilicis** on twigs, also leaf spot, CA, NJ, NY, NC, SC, TX, WA, WV; **Gloeosporium** sp., AL.

CANKER, Felt Fungus. **Septobasidium** spp., FL, LA, NC.

DODDER. **Cuscuta compacta**, FL; **C. exaltata**, TX.

LEAF SPOT. **Cercospora ilicis**, NJ and Gulf states; **Gloeosporium aquifolli**, NJ, TX, WA; **Macrophoma phacediella**, NJ; **Microthyriella cuticulosa**, black spot; **Phyllosticta concomitans**, LA; **P. terminalis**, MS; **Septoria ilicifolia**, NJ; **Cuticularia ilicis**, OR; **Sclerophoma** sp., OR.

LEAF SPOT. **Sclerophoma** sp., Kentucky on English Holly (*Ilex aquifolium*).

LEAF SPOT, Tar. **Phacidium curtisii**, MA to FL,TX; **Rhytisma ilicinicolum**, VA to GA, TN; **R. velatum**, GA, MS, SC.

LEAF SPOT; Twig Dieback. **Cylindrocladium avesiculatum**, GA.

NEMATODE, Lance. **Hoplolaimus uniformis**, RI.

NEMATODE, Root Knot. **Meloidogyne incognita**; **M. incognita**; **M. arenaria**, NC; **M. hapla**; **M. javanica**.

NONPARASITIC. **Leaf Blotch**. Purplish blotches associated with soil deficiencies and drought or winter injury.

Chlorosis. Mineral deficiency from excess of lime.

Spine Injury; **Copper Spray Injury**; **Boron Deficiency**.

POWDERY MILDEW. **Microsphaera alni**, AL, FL, IL, NC; **Phyllactinia corylea**, TN.

ROT, Leaf. **Rhizoctonia solani**, of cuttings.

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX; **Corticium galactinum**, white root, MD.

ROT, Wood. **Daldinia vernicosa**, MD; **Daedalea confragosa**, MD; **Polyporus** spp.; **Stereum** spp., MD; **Ustulina deusta**, MD; **Poria** spp.; **Pleurotus ostreatus**, MD.

RUST. **Chrysomyxa ilicina** (II, III), NC, TN, WV, 0, I unknown.

SOOTY MOLD. **Capnodium elongatum**, Gulf states; **Fumago vagans**, OR, WA.

SPOT ANTHRACNOSE. **Elsinoë ilicis**, PA, on Chinese holly.

None of these diseases is as important to the average gardener as the holly leaf miner. Spraying is necessary for that insect but seldom obligatory for

the various leaf spots. The most common leaf discoloration is a purplish blotch due to environment rather than a fungus. Proper growing conditions and correct soil acidity are important. Pick off occasional spotted leaves; prune out blighted branches.

HOLLYHOCK (*Althaea*)

ANTHRACNOSE. **Colletotrichum malvarum**, NY to MS, IA, TX.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, WI.
BACTERIAL Wilt. **Pseudomonas solanacearum**, NY, WV.
BLIGHT, Southern. **Sclerotium rolfsii**, AR.
BLIGHT, Web. **Pellicularia filamentosa**, TX.
CANKER. **Nectria cinnabarina**, OK.
LEAF SPOT. **Alternaria** spp., secondary; **Ascochyta althaeina**, IN, MD, NJ, NY, PA, WV; **Cercospora althaeina**, East and central states to AL, SD, TX; **C. kellermanii**, IN, MD, MN, MO, NJ, OH; **Myrothecium roridum**, MD; **Septoria malvicola**, MI, MN, NY, OH, OK, VT, WI.
NEMATODE, Lesion. **Pratylenchus pratensis**, TX.
NEMATODE, Root Knot. **Meloidogyne** spp., FL, KS, MS, OK, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, MS; **Erysiphe polygoni**, IA.
ROT, Crown. **Phytophthora megasperma**, MD, VA; **Sclerotinia sclerotiorum**, MT, NJ.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia malvacearum** (III), general; **P. heterospora** (III), CA, KS, MS, TX; **P. lobata**, AZ, NM, TX; **P. schedonnardi** (0, I), KS, MS, NE, ND; **P. sherardiana** (0, III), CA; **Endophyllum tuberculatum** (III), CO, KS, NE, OK.
VIRUS. **Hollyhock Mosaic**.

Rust is by far the most destructive disease of hollyhocks, disfiguring foliage in most seasons and some years causing nearly all leaves to shrivel and die. Remove infected leaves and stalks as noticed.

HOLLY OSMANTHUS (*Osmanthus ilicifolius*)

LEAF SPOT. **Phyllosticta oleae**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rosellinia necatrix**, CA.
SOOTY MOLD. **Capnodium elongatum**, TX; **Fumago salicina**, TX.
WILT. **Verticillium albo-atrum**, VA.

HOLLY, WEST INDIAN (*Leea coccinea*)

LEAF SPOT, Blight, Defoliation. **Phytophthora meadii**, HI.

HOLODISCUS (Ocean Spray, Rock-Spirea)

CANKER, Twig; Coral Spot. **Nectria cinnabarina**, WA.
LEAF SPOT. **Cylindrosporium ariaefolium**, OR; **Rhopalidium cercosporelloidis**, ID, **Septogloeum schizonoti**, WA.
POWDERY MILDEW. **Podosphaera oxyacanthae**, ID, **Phyllactinia corylea**, WA.
VIRUS. **Holodiscus Witches' Broom**, OR, WA.

HOMALOMENA

LEAF SPOT. **Glomerella cincta**, NJ.

HONESTY (*Lunaria*)

CLUB ROOT. **Plasmodiophora brassicae**, NJ.
LEAF SPOT. **Alternaria oleracea**, black spot of leaves, pods; **Helminthosporium lunariae**, MA.
ROT, Root; Damping-off. **Aphanomyces raphani**, WI.

HONEY LOCUST (*Gleditsia*)

BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, central states.
CANKER. **Dothiorella** sp., MS; **Cytospora gleditschiae**, IL; **Physalospora obtusa**.
CANKER, Felt Fungus. **Septobasidium curtisii**, AR, LA.
CANKER, Stem and Branch. **Kaskaskia gleditsiae**, IL; **Tubercularia ulmea**, ND; **Nectria cinnabarina**, MN; **Thyronectria austro-americana**, KS, NC.

CANKER; Wilt. **Thyronectria austro-americana**, CA, MA; **T. denigrata**, MA to SC, LA, NE, CA.
LEAF SPOT. **Cercospora condensata**, IL to KS, NE, WI.
LEAF SPOT, Tar. **Linospora gleditsiae**, SC, NC to NE, TX.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), IN, TX.
POWDERY MILDEW. **Microsphaera alni**, widespread.
ROT, Crown. **Phytophthora citrophthora**, CA.
ROT, Root. **Phymatotrichum omnivorum**, OK, TX; **Xylaria mali**, VA.
ROT, Wood. **Fomes** spp., widespread; **Daedalea ambigua**; **D. elegans**; **Ganoderma curtisii** and **G. lucidum**; **Polyporus** spp.; **Schizophyllum commune**.
RUST. **Ravenelia opaca** (III), IL.
VIRUS. **Robinia Brooming**, KY, OH.

HONEY PLANT, BITTERBUSH (*Picramnia*)

SPOT, Tar. **Phyllachora domingensis**, FL.

HONEYSUCKLE (*Lonicera*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, central states.
BLIGHT, Leaf. **Herpobasidium deformans**, CT, IA, NY, WI.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, CT.
BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, CA.
BLIGHT, Thread. **Pellicularia koleroga**, LA.
BLIGHT, Twig. **Phoma mariae**, CT, MA, NY.
LEAF SPOT. **Cercospora antipus**, MI to MT, TX; **C. varia**, TX; **Guignardia lonicerae**, CA; **Kabatia lonicerae**, CA; **Lasiobotrys affinis**, CA; **L. lonicerae**, Black Spot, OR; **Leptothyrium periclymeni**, widespread; **Marssonina lonicerae**, CA; **Mycosphaerella clymenia**, VA; **Septoria sambucina**, MT, WI; **S. xylostei**, WI.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Microsphaera alni**, general; **Erysiphe polygoni**, CA, WY.
ROT, Collar, Wood. **Fomes** spp.
ROT, Root. **Armillaria mellea**, NJ; **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia festucae** (I), IL, IA.
VIRUS. **Mosaic**, MD; **Tobacco Streak**, MD.

HOP (*Humulus*)

ANTHRACNOSE; Leaf Spot. **Colletotrichum** sp.; **Glomerella cingulata**, IN, KS, MD, NY, OR, WA, WI.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA, OK, OR, WA.
BLIGHT, Cone Tip. **Fusarium sambucinum**, **F. avenaceum**, OR.
DOWNY MILDEW. **Pseudoperonospora humuli**, CA, NY, OR, WA, WI.
LEAF SPOT. **Cercospora** sp., NE; **Cylindrosporium humuli**, NY to NC, IA, WI; **Phyllosticta decidua**, IA, WI; **P. humuli**, IA, MA, MI; **Mycosphaerella erysiphina**, CA; **Septoria humuli**, NH; **S. lupulina**, KS.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**; **Sphaerotheca macularis**, general.
ROT, Root. **Armillaria mellea**, OR.
RUST. **Aecidium** sp., WA.
SOOTY MOLD. **Fumago vagans**, CA, OR, WA.
VIRUS. **Hop Mosaic**, NY, OR, WA; **Hop Latent**; **Hop American Latent**, WA.
WILT. **Verticillium albo-atrum**, ME, OH, OR, WI.

HOP-HORNBEAM, IRONWOOD (*Ostrya*)

CANKER. **Nectria** sp., NY; **Strumella coryneoidea**, MD, PA, WV.
CANKER, Bark Patch. **Aleurodiscus** spp.; Felt Fungus, **Septobasidium** spp.
LEAF BLISTER. **Taphrina virginica**, NH to FL, TX, WI.
LEAF SPOT. **Cylindrosporium dearnessi**, VA; **Gloeosporium robergei**, PA, WI; **Septoria ostryae**, IA, NY, WI.
POWDERY MILDEW. **Microsphaera alni**, widespread; **Phyllactinia corylea**, NY to FL, TX, WI; **Uncinula macrospora**, MI, WI.
ROT, Root. **Armillaria mellea**, cosmopolitan; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Daedalea confragosa**, cosmopolitan; **Fomes** spp.; **Pleurotus similis**, NY; **Poria** spp.; **Polyporus** spp.; **Stereum** spp.; **Trametes mollis**, NY, VT.

RUST. **Melampsoridium carpini** (II, III), NY; 0, I, unknown.

HOP-TREE (*Ptelea*)

LEAF SPOT. **Cercospora afflata**, IN, MO, TX; **C. pteleae**, TX; **Phloeospora pteleae**, TX; **Phyllosticta pteleicola**, IL; **Septoria pteleae**, WI.

RUST. **Puccinia windsoriae** (0, I), NY to AL, KS; II, III on grasses.

ROT, Root. **Phymatotrichum omnivorum**, TX.

HORNBEAM (*Carpinus*)

BLIGHT, Twig, Dieback. **Gibberella baccata**, AL.

CANKER, Bark Patch. **Aleurodiscus oakesii**, NY.

CANKER, Branch, Trunk. **Nectria galligena**, CT, NY; **Pezicula carpinea**, MA to GA, OK.

CANKER, Felt Fungus. **Septobasidium** spp., VA to FL, LA.

LEAF BLISTER. **Taphrina australis**, AL, CT, KY.

LEAF SPOT. **Clasterosporium cornigerum**, MD, NY, WI; **Cylindrosporium dearnessi**, MI; **Phyllosticta** sp., OK; **Sphaerognomonia carpinea**, GA, NY, PA, WV, WI;, **Cercoseptoria caryigena**, WI.

POWDERY MILDEW. **Microsphaera alni**, MA, IN, IA, MI, TX; **Phyllactinia corylea**, AL, IN, OH, TX, WI.

ROT, Root. **Armillaria mellea**, FL; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Daedalea confragosa**, NC; **Polyporus** spp., general; **Poria** spp., general; **Steccherinum** sp., CT; **Stereum** spp., general; **Daldinia concentrica**, MD; **Schizophyllum commune**, cosmopolitan.

HORSE-CHESTNUT, BUCKEYE (*Aesculus*)

ANTHRACNOSE; Leaf Blight. **Glomerella cingulata**, CT, MD, MO, NJ, NY, TX.

BLIGHT, Twig. **Botryosphaeria ribis** var. **chromogena**, MD, NY, GA.

BLOTCH, Leaf. **Guignardia aesculi** (*Phyllosticta paviae*), general.

CANKER; DIEBACK. **Nectria cinnabarina**, cosmopolitan; **Phytophthora cactorum**, bleeding canker, RI; **Gibberella acuminatum**, CA.

LEAF BLISTER, Yellow. **Taphrina aesculi**, CA, TX.

LEAF SPOT. **Cercospora aesculina** FL, VA; **Macrosporium baccatum**, KS; **Monochaetia desmazierii**, NC; **Micosphaerella maculiformis** var. **hippocastani**, CA; **Septoria glabra**, IN; **S. hippocastani**, PA, VT, (Sudden Oak Death) **Phytophthora ramorum**, CA.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), South, central states; **P. villosum**, CA, OR, TX.

MISTLETOE. **Viscum album**, CA, on *Aesculus californica* (California Buckeye).

NONPARASITIC. **Scorch**; **Leaf Scald**. Response to drought and heat.

POWDERY MILDEW. **Phyllactinia corylea**, CA, TX; **Uncinula flexuosa**, widespread.

ROT, Root. **Armillaria mellea**, cosmopolitan; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Collybia velutipes**, RI; **Ganoderma applanatum**, cosmopolitan; **Polyporus** spp.

RUST. **Aecidium aesculi**, IN, KS, MO, NE.

WILT. **Verticillium albo-atrum**, PA.

In a wet season leaves are blotched, turn brown, and drop from the *Guignardia* fungus; in a dry season leaves look scorched or blotched, turn brown, and drop from drought and heat. The minute black fruiting bodies of the fungus distinguish the parasitic form from the physiogenic disease.

HORSE-GENTIAN (*Triosteum*)

LEAF SPOT. **Cladosporium triostei**, IL, IA, MO, NE, WV, WI; **Cylindrosporium triostei**, IL, KS, OK, WI; **Cercospora triostei**, WI.

POWDERY MILDEW. **Phyllactinia corylea**, MI.

RUST. **Aecidium triostei** (0, I), MO.

HORSE PURSLANE (*Trianthema*)

LEAF SPOT. **Gibbago trianthemae**, AR.

HORSE-RADISH (*Armoracia*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, NJ, NY.
BACTERIAL Leaf Spot. **Xanthomonas campestris** pv. **armoraciae**, CT, IL, IA, MD, MO, SD, VA; **X. phaseoli**, IL.
BACTERIAL, MLO.
ROOT, Brittle, disease, virescence. **Spiroplasma citri**, CA, IL, MD.
BACTERIAL Soft Rot. **Erwinia carotovora**, in stored roots, CT, NY.
CLUB ROOT. **Plasmodiophora brassicae**, IL.
DOWNY MILDEW. **Peronospora parasitica**, AL, IL, NJ, SD, WI.
LEAF SPOT. **Alternaria brassicae**, CT to DE, IL, IA; **A. oleracea**, CT to DE, MO, NE, TX; **Cercospora armoraciae**, general; **Phyllosticta decidua**, TX, WA, WI; **P. orbicula**, NY; **Ramularia armoraciae**, general.
NEMATODE, Root Knot. **Meloidogyne** sp., IL, MS, OK.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Blue Mold. **Penicillium hirsutum**, IL, NJ.
ROT, Collar, Root. **Pellicularia filamentosa**, IL, MI, NJ, NY, TX, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Thielaviopsis basicola**, KS, NJ.
ROT, Root Complex. **Fusarium acuminatum**, **Verticillium dahliae** and **Pseudomonas fluorescens**, IL, WI.
VIRUS. **Beet Curly Top**, CA, IL, KS, OR, UT, WA; **Turnip Mosaic**, widespread.
WHITE RUST. **Albugo candida**, probably general.
WILT. **Verticillium albo-atrum**, MI, WA.

HORSEWEED (*Conyza*)

ROT. **Sclerotinia minor**, NC.
VIRUS. **Tomato Spotted Wilt**, GA.

HOSTA (*Plantain-Lily*)

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.
LEAF SPOT. **Alternaria** sp., NY; **Phyllosticta** sp., NJ.
NEMATODE, LEAF LESION. **Aphelenchoides fragariae**, IL, NY, SC.

ROT, Crown. **Botrytis cinerea**, AK, NJ; **Sclerotium rolfsii** (*S. delphinii*), CT, MD, MN, NJ, NY.

ROT, Root. **Rhizoctonia solani**, NJ; **Fusarium solani**, **F. oxysporum**, **F. proliferatum** (Root and Crown), SC.

VIRUS. **Hosta Virus X**, IL, IN, IA, MN, HI; **Tobravirus, Leaf Necrosis**, IL, MI, MN; **Tomato Spotted Wilt**, FL; **Impatiens Necrotic Spot**, NY; **Arabis Mosaic**, MI, MN, NE.

HOUSTONIA (*Bluets*)

DOWNY MILDEW. **Peronospora calotheca**, IL; **P. seymourii**, AL, AR, IL, IA, MS, TX.

LEAF SPOT. **Cercospora houstoniae**, DE; **Septoria** sp., TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia lateritia**, TX; **Uromyces houstoniatus** (0, I), MA to MS, IL, MO, WI; II, III on blue-eyed grass; **U. peckianus** (0, I), AL, MS, TX; II, III on grasses.

HOYA

LEAF SPOT. **Myrothecium roridum**, FL.

HUCKLEBERRY EVERGREEN (*Vaccinium*)

BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, CA.

HUCKLEBERRY (*Gaylussacia*)

BLACK MILDEW. **Dimerosporium ellissi**, MS, NJ.

DODDER. **Cuscuta** sp., PA.

GALL, Leaf. **Exobasidium vaccinii**, ME to VA, AL, FL, WI; **Synchytrium vaccinii**, red lead, NJ.

LEAF SPOT. **Ophiodothella vaccinii**, TX; **Pestalotia vaccinii**, WV; **Phyllosticta** sp., NJ, PA; **Ramularia effusa**, WI; **Rhytisma vaccinii**, tar spot, MA, OK, SC.

NEMATODE, Root Knot. **Meloidogyne** sp., OK.

POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, widespread.
RUST. **Pucciniastrum myrtilli** (II, III), ME to VA, WI; 0, I on hemlock.

HUISACHE, SWEET ACACIA (*Acacia farnesiana*)

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Ravenelia australis**, TX; **R. hieronymi**, witches' broom, TX; **R. siliquae**, NM, TX.

HYACINTH (*Hyacinthus*)

BACTERIAL Soft Rot. **Erwinia carotovora**, cosmopolitan.
BACTERIAL Yellows. **Xanthomonas hyacinthi**, occasional in imported bulbs.
BLIGHT, Gray Mold. **Botrytis hyacinthi**, WA; **B. cinerea**, NC, after frost.
NEMATODE, Bulb; Ring Disease. **Ditylenchus dipsaci**, NJ, Pacific states.
NONPARASITIC. **Loose Bud**; **Stem Break**. Excessive water intake during early shoot growth.
ROT, Black. **Sclerotinia sclerotiorum**, Pacific Northwest; **S. bulborum**, black slime.
ROT, Bulb. **Fusarium** sp., CO, MO, NJ, RI, TX, WA; **Penicillium** spp., blue mold, cosmopolitan.
ROT, Root. **Phytophthora** sp., NJ.
VIRUS. **Ornithogalum Mosaic**, CA, MD, NY, OR, TX, WA; **Hyacinth Mosaic**, OR.

HYDRANGEA

BACTERIAL LEAF SPOT. **Xanthomonas campestris**, GA.
BACTERIAL, MLO. **Hydrangea virescence**.
BACTERIAL Wilt. **Pseudomonas solanacearum**, NY.
BLIGHT, Flower; Gray Mold. **Botrytis cinerea**, cosmopolitan, especially after frost.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.
LEAF SPOT. **Ascochyta hydrangeae**, AK, NJ; **Cercospora arborescentis**, IL, OK; **C. hydrangeae**, MD, VA to AL, FL, TX; **Colletotrichum** sp.,

MD, NJ; **Phyllosticta hydrangeae**, IN; **Septoria hydrangeae**, CT, MS, OH; **Corynespora cassiicola**, FL, GA; **Phoma exigua**.

NEMATODE, Leaf. **Aphelenchoides** sp.

NEMATODE, Lesion. **Pratylenchus pratensis**, TX.

NEMATODE, Root Knot. **Meloidogyne** spp., MS, OK, TX.

NEMATODE, Stem, Bulb. **Ditylenchus dipsaci**.

NONPARASITIC. **Chlorosis**. Iron deficiency, excess lime.

POWDERY MILDEW. **Erysiphe polygoni**, general.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Armillaria mellea**, CA.

ROT, Stem. **Rhizoctonia solani**, MD; wound, **Polyporus versicolor**, CT, IA, MD.

RUST. **Pucciniastrum hydrangeae** (II, III), PA to AR, IL; 0, I on hemlock.

VIRUS. **Hydrangea Ring Spot**; **Tomato Spotted Wilt**; **Hydrangea Latent**.

HYDRILLA

DYING SHOOTS. **Plectosporium tabacinum**, FL, Bioassay indicated that **Botrytis** sp., **Cephalosporium** sp., **Curvularia** sp., **Fusarium culmorum**, **F. moniliforme**, and **Phytophthora** sp. were pathogenic to hydrilla. Notes: Hydrilla is a submerged aquatic weed. It is an exotic, invasive species that is a threat to fresh water sources in the USA.

HYDROPHYLLUM (*Waterleaf*)

DOWNY MILDEW. **Peronospora hydrophylli**, IL, IA, MD, NY, WA, WI.

LEAF SPOT. **Ascochyta hydrophylli**, WA; **Gloeosporium hydrophylli**, NH; **Ramularia hydrophylli**, WA; **Septocylindrium hydrophylli**, NY; **Septoria hydrophylli**, NY.

POWDERY MILDEW. **Golovinomyces cichoracearum**, occasional; **Erysiphe polygoni**, ID, WA; **Sphaerotheca macularis**, ND, OH, SD.

ROT, Leaf and Stem. **Ceratobasidium anceps**, NY, WI.

RUST. **Puccinia hydrophylli** (III), CA, CO, NY to NE, ND, UT; **P. recondita** (0, I), MT, widespread; II, III on grasses.

HYMENOPAPPUS

DOWNY MILDEW. **Plasmopara halstedii**, OK.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia grindeliae** (0, III), OK.

HYSSOP (*Hyssopus*)

NEMATODE, Root Knot. **Meloidogyne** sp., MI.

ICE PLANT (*Carpobrotus*)

ROT, Root. **Pythium aphanidermatum**, CA; **Phytophthora cryptogea**, CA.
WILT. **Verticillium dahliae**, CA; **Phomopsis** sp., CA.

IMPATIENS (Garden Balsam, Sultan)

BACTERIAL BLIGHT LEAF. **Pseudomonas syringae**, CA.
BACTERIAL FASCIATION. **Clavibacter fascians**, CA.
BACTERIAL Wilt. **Pseudomonas solanacearum**, WI.
DAMPING-OFF. **Pythium** sp., WA; **Rhizoctonia solani**, FL.
DOWNY MILDEW. **Bremiella sphaerosperma**, IN, MN, MS, MT, WI, Manitoba, Quebec, Canada; **Plasmospora obducens**, CA.
LEAF SPOT. **Cercospora fukushiana**, FL, KS; **Septoria noli-tangeris**, OH; **Phyllosticta** sp., NJ.
GALL, Leaf. **Synchytrium impatientis**, LA.
NEMATODE, Lesion. **Pratylenchus penetrans**.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Crown. **Pythium ultimum** and **Rhizoctonia solani**.
ROT, Mushroom Root. **Armillaria mellea**, CA.
ROT, Stem. **Sclerotium rolfsii**; **Myrothecium roridum**.
VIRUS. **Cucumber Mosaic**, SC; **Impatiens Latent**, MN; **Impatiens Necrotic Spot**, NC; **Tomato Spotted Wilt**, FL, GA, NC, OK; **Turnip Mosaic**, NY; **Tobacco Ringspot**, IA, MN.
WILT. **Verticillium albo-atrum**, NY; **Verticillium dahliae**, OH.

INCENSE-CEDAR (*Libocedrus* [= *Calocedrus decurrens*])

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, AZ, CA.
BLIGHT, Brown Felt. **Herpotrichia nigra**, CA.
CANKER, Branch. **Coryneum cardinale**, CA.
MISTLETOE. **Phoradendron juniperinum**, CA, NV, OR.
NEEDLE CAST. **Lophodermium juniperinum**, CA, OR.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Armillaria mellea**, OR.
ROT, Wood. **Fomes pini** and **F. pinicola**, CA, OR; **Lenzites saepiaria**, general; **Polyporus** spp.; **Trametes isabellina**, CA.
RUST. **Gymnosporangium libocedri**, gall, witches' broom (II, III), CA, NV, OR; 0, I on apple and other *Malaceae*.

INDIA-HAWTHORN (*Raphiolepis*)

BACTERIAL, Fire Blight. **Erwinia amylovora**, FL, GA, LA.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.
LEAF SPOT. **Entomosporium maculatum** (*Fabraea maculata*), CA.

INDIAN CUCUMBER-ROOT (*Medeola*)

GALL, Stem Hypertrophy. **Medeolaria farlowii**, ME, MA, NJ.
LEAF SPOT. **Phyllosticta medeolae**, NY.

INDIAN GRASS (*Sorghastrum*)

LEAF SPOT. **Ascochyta brachypodii**, NY, PA.
VIRUS. **Barley Yellow Dwarf**.

INDIGO (*Indigofera*)

CANKER, STEM. **Diaporthe phaseolorum** var. **caulivora**, LA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Ravenelia laevis**, TX; **Uromyces indigoferae** (II, III), FL, TX.

INDIGO-BUSH, LEAD-PLANT (*Amorpha*)

LEAF SPOT. **Cylindrosporium passaloroides**, widespread; **Diplodia amorphae**, TX.
POWDERY MILDEW. **Erysiphe polygoni**, IA, MN, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Uropyxis amorphae** (0, I, II, III), general.

INKBERRY (Ilex glabra)

BLACK MILDEW. **Asterina ilicis**, NJ; **Morenoella ilicis**, FL, GA, MS.
BLIGHT, Thread. **Pellicularia koleroga**, LA.
CANKER, Felt Fungus. **Septobasidium** spp., FL.
DODDER. **Cuscuta compacta**, FL.
LEAF SPOT. **Cercospora ilicis**, AL, FL, MS, NJ; **Phacidium curtisii** and **P. sphaerodieum**, tar spot, MA to FL, and TX; **Phytophthora cinnamomi**, (leaf spot, yellowing and wilting), VA.
ROT, Wood. **Poria versipora**, AR, LA.

INULA (*Elecampane*)

LEAF SPOT. **Ramularia** sp., MI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, NJ, NY, WI, probably general.
RUST. **Puccinia hieracii**, WI.
Inula is very susceptible to powdery mildew, which coats the foliage white in late summer.

IRESINE (Blood-Leaf)

LEAF SPOT. **Septoria iresines**, OK.
NEMATODE, Root Knot. **Meloidogyne** sp., FL, MD.
ROT, Root. **Helicobasidium purpureum**, TX; **Rhizoctonia solani**, IL.
SMUT, Inflorescence. **Thecaphora iresine**, IN.

IRIS (Bulbous) (English, Spanish, Dutch)

BLIGHT, Blossom. **Botrytis cinerea**; **Glomerella cingulata**, MD.

BLIGHT, Leaf; Ink Disease of Bulbs. **Mystrosporium adustum**, NC, OR, VA.

BLIGHT, Southern; White Bulb Rot. **Sclerotium rolfsii**, CA, CT, FL, MD, NC, OR, SC, TX.

LEAF SPOT, Blight. **Didymellina macrospora**, CA, NC, TX, WA.

NEMATODE, Bulb. **Ditylenchus dipsaci** (*D. iridis*), FL, NY, NC, OR, SC, VA, WA.

NEMATODE, Root Knot. **Meloidogyne** sp., NC.

NEMATODE, Root Plate. **Aphelenchoides parietinus**, MI, NY, NC, TX, WA.

NONPARASITIC. **Blindness**. Complex physiological causes.

ROT, Basal. **Fusarium oxysporum**, AZ, CA, NY, NC, OR, TX, VA, WA.

ROT, Black. **Sclerotinia bulborum**, bulb rot, Northwest; **Rhizoctonia tuliparum**, occasional; Blue Mold, **Penicillium** spp., general.

ROT, Root, Neck. **Rhizoctonia solani**, NJ, Pacific Northwest.

RUST. **Puccinia iridis** (II, III), CA, IN, LA, NC.

VIRUS. **Iris Mosaic**, general; **Iris Severe Mosaic**.

IRIS (Rhizomatous) (German, Siberian, Native Species)

BACTERIAL Soft Rot. **Erwinia carotovora**, general.

BLIGHT, Blossom. **Botrytis cinerea**, MA.

BLIGHT, Southern; Crown Rot. **Sclerotium rolfsii** (*S. delphinii*), general.

LEAF SPOT. **Alternaria iridicola**, IL, MT, TX, WA WI; **Didymellina macrospora** (*Heterosporium iridis*); **Ascochyta iridis** MD, NY; **Cladosporium herbarum**, secondary; **Kabatiella microsticta**, secondary; **Phyllosticta iridis**, FL, MI, NY, OH, TX, WI; **Stictopatella iridis**, IL.

NEMATODE, Root Knot. **Meloidogyne incognita**.

NONPARASITIC. **Scorch**. Cause unknown, sometimes associated with nematodes.

ROT, Gray Mold; Crown. **Botryotinia convoluta**, MN, NJ, NY, WI.

ROT, Root; Damping-Off. **Rhizoctonia solani**, occasional.

RUST. **Puccinia iridis** (II, III), widespread on native species; most garden varieties are resistant. **P. sessilis** (0, I), ME to NE, MN; II, III on *Phalarus*.

VIRUS. **Iris Severe Mosaic**; **Iris Fulva Mosaic**, MA.
The most common disease of bearded iris in home gardens is bacterial soft rot following iris borer. Crown rot or southern blight gets started when iris is too crowded. Didymellina leaf spot or blight may be conspicuous in a wet summer. The physiological () disease, scorch, is causing concern, particularly in central states.

IRONWEED (*Vernonia*)

BLACK MILDEW. **Stigmella vernoniae**, MO.
DOWNY MILDEW. **Plasmopara halstedii**, KS, MO.
LEAF SPOT. **Cercospora noveboracensis**, MO; **Ascochyta treleasei**, WI; **Mycosphaerella** sp.; **Septoria** sp., MO; **C. oculata**, WV to AL, NE, TX, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Sphaerotheca macularis**, MO.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium vernoniae** (I, III), general; 0, I on pine; **Puccinia vernoniae** (0, I, II, III), widespread.

ITALIAN DANDELION (*Cichorium intybus*)

BACTERIAL, Leaf Spot. **Pseudomonas syringae**

ITCHGRASS (*Rottobellia*)

BLIGHT. **Curvularia cymbopogonis**, LA.
ROT, Root. **Pythium arrhenomanes**, LA.

IVESIA

RUST. **Phragmidium horkeliae** (III), UT; **P. ivesia**, CA; **P. jonesii**, NV, OR, UT.

IVY, BOSTON (*Parthenocissus tricuspidata*)

CANKER; DIEBACK. **Cladosporium herbarum**, IN, NJ, OH, PA.
DOWNY MILDEW. **Plasmopara viticola**, NJ, TX.

LEAF SPOT. **Cercospora amelopsidis**, MS; **C. pustulata**, TX; **Guignardia bidwellii** f. sp. **parthenocissi** widespread; **Phloeospora ampelopsidis**, IA; **Sphaeropsis hedericola**, NJ.
NEMATODE, Dagger. **Xiphinema index**, CA.
POWDERY MILDEW. **Uncinula necator**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Pellicularia filamentosa**, CT.
The Guignardia leaf spot is common and disfiguring.

IVY, ENGLISH (*Hedera helix*)

ANTHRACNOSE. **Amerosporium** (*Colletotrichum*) **trichellum**, MA to SC, OK, OR, TX, WA.
BACTERIAL SPOT. **Xanthomonas hederae**, GA, IL, MD, NJ, NY, VA, WA.
DODDER. **Cuscuta** sp., AZ, NJ.
LEAF SPOT. **Glomerella cingulata**, CT, MD, NY, TX; **Phyllosticta concentrica**, MA to AL, CA, NE, TX. WA; **Ramularia hedericola**, TX; **Sphaeropsis hedericola**, NY, WV; **Macrophoma** sp., TX.
MOLD, Leaf. **Cladosporium brunneolum**, CA.
NONPARASITIC. **Winter Injury**. Sunburn, Freezing.
POWDERY MILDEW. **Golovinomyces cichoracearum**, OK; **Oidium araliacearum**, CA.
ROT, Root. **Phytophthora palmivora**, CA.
ROT, Root. **Rhizoctonia solani**, CT; **Phymatotrichum omnivorum**, TX.
SOOTY MOLD. Common under trees, on insect exudate.
SPOT ANTHRACNOSE; Ivy Scab. **Sphaceloma hederae**, CA, NC, VA.
Leaf spots are not often important in the garden but browning of foliage from winter injury is conspicuous in early spring. English ivy used as a ground cover is often black, with sooty mold growing in honeydew dropped from aphids in trees overhead. Dodder sometimes gets a strangle hold and is difficult to eradicate.

IXIA

ROT, Corm. **Fusarium oxysporum** f. sp. **gladioli**; **Sclerotium** sp.
VIRUS. **Iris Mosaic**, OR, WA.

IXORA

NEMATODE, Burrowing. **Radopholus similis**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Root. **Clitocybe tabescens**, FL.

JACARANDA

ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

JACK-BEAN, SWORD BEAN (*Canavalia*)

LEAF SPOT. **Cercospora ternateae**, AL.
NEMATODE, Root Knot. **Meloidogyne** spp., FL. Usually resistant.
POD SPOT. **Vermicularia capsici**, FL; **V. polytricha**, AL.
VIRUS. **Potato Virus X**, WI.

JACK-IN-THE-PULPIT (*Arisaema*)

BLIGHT, Leaf and Stalk. **Streptotinia arisaemae** (*Botrytis streptothrix*), IL, IA, MD, NY, PA, WI.
LEAF SPOT. **Cladosporium** sp., mold, VA; **Volutella** sp., IN.
RUST. **Uromyces ari-triphylli** (0, I, II, III), NY to FL and TX; Pacific Northwest.

JACOBINIA

NEMATODE, Burrowing. **Radopholus similis**, FL.

JACQUEMONTIA (Small Flower Morning Glory)

CANKER, STEM. **Diaporthe phaseolorum** var. **caulivora**, LA.
LEAF SPOT. **Cercospora alabamensis**, MS.
NEMATODE, Reniform. **Rotylenchulus reniformis**, GA, LA.
NEMATODE, Root Knot. **Meloidogyne** sp., AL; **Meloidogyne incognita**, LA.

ROT, Root. **Streptomyces ipomoea**, LA; **Ceratocystis fimbriata**, LA; **Fusarium oxysporum** f. sp. **batatas**, LA; **Plenodomus destruens**, LA; **Monilochaetes infuscans**, LA.
RUST. **Coleosporium ipomoeae** (II, III), LA.
VIRUS. **Tomato Spotted Wilt**, GA, TX.
WHITE RUST. **Albugo ipomoeae-panduratae**, AL.

JACQUINIA

BLACK SPOT. **Asterella paupercula**, FL.

JAMESIA (Cliffbrush)

BLIGHT. **Ovularia edwiniae**, CO.

JASMINE (*Jasminum*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD.
BLIGHT, Blossom. **Choanephora infundibulifera**, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, FL.
CANKER, Stem Gall. **Phomopsis** sp., FL; **Phoma** sp., TX.
LEAF SPOT. **Colletotrichum gloeosporioides**, FL, TX.
LEAF SPOT, Algal; Green Scurf. **Cephaleuros virescens**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Root. **Clitocybe tabescens**, FL; **Corticium galactinum**, MD.
SPOT ANTHRACNOSE. **Elsinoë jasminae**, FL.
VIRUS. **Tobacco Ring Spot**, MD.
VIRUS. Variegation; Infectious Chlorosis.

JATROPHA

BLACK MILDEW. **Meliola jatrophae**.
LEAF SPOT. **Colletotrichum gloeosporioides**, FL.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Phakopsora jatrophicola** (II, III), TX.

JERUSALEM-CHERRY (*Solanum pseudocapsicum*) (Also *Solanum capsicastrum*, False Jerusalem- cherry; *S. dulcamara*, Bittersweet; *S. integrifolium*, Scarlet Eggplant; *S. nigrum*, Black nightshade)

BACTERIAL Canker. **Clavibacter michiganense**, WY. Also on *S. dulcamara* (Bittersweet).
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT.
BLIGHT, Late. **Phytophthora infestans**, MD, NY.
CANKER, STEM. **Diaporthe phaseolorum** var. **caulivora**, LA.
DODDER. **Cuscuta gronovii**, NY.
LEAF SPOT. **Alternaria solani**; **Mycosphaerella solani**, OH; **Ascochyta lycopersici**, NY, OH; **Cercospora dulcamerae**, MI, NY, WI; **Phyllosticta pseudocapsici**, LA; **Stemphylium solani**, FL.
NEMATODE, Root Knot. **Meloidogyne** spp., CA, MD, OR.
NEMATODE, Tobacco Cyst. **Heterodera tabacum**, VA.
PARASITIC Lichen. **Strigula elegans** and **S. complanata**, southern U.S., LA.
VIRUS. **Beet Curly Top** on False Jerusalem-cherry (*S. capsicastrum*)
VIRUS. **Tobacco Mosaic**, IA, VA; **Tomato Spotted Wilt**, tip blight, OR.
WILT. **Verticillium albo-atrum**, NY.

JETBEAD (*Rhodotypos*)

ANTHRACNOSE. **Gloeosporium** sp., IL.
BLIGHT, Twig; Coral Spot. **Nectria cinnabarina**, MA.
LEAF SPOT. **Ascochyta rhodotypi**, IL.

JIPIJAPA (*Carludovia palmata*)

PHYTOPLASMA. **Leaf Yellows**, southern Mexico.

JOBS-TEARS (*Coix lachryma-jobi*)

SMUT, Head. **Ustilago coicis**. Intercepted on imported seed.
VIRUS. **Chlorotic Streak**.

JOHNSONGRASS (Sorgum)

BACTERIALLeaf Blight. **Acidovorax avenae** (syn. **Pseudomonas avenae**), IL.
DOWNY MILDEW. **Peronosclerospora sorghi**, TX.
ERGOT. **Claviceps africana**, TX; **Sphacelia** sp., MS.
LEAF SPOT, Oval. **Ramulispora sorghicola**, TX.
ROT, Root. **Pythium arrhenomanes**, LA; **P. ultimum**, MS.
VIRUS. **Johnsongrass Mosaic**; **Sorghum Stunt Mosaic**, CA; **Sorghum Chlorotic Spot**, KS.

JOINTWEED (*Polygonello articulata*)

RUST. **Puccinia polygoni-amphibii** (II, III), FL, WI.

JOJOBA (*Simmondsia*)

BLIGHT, LEAF. **Phytophthora parasitica**, AZ.

JUJUBE (*Zizyphus*)

LEAF SPOT. **Cercospora jujubae**, FL.
RUST. **Phakopsora zizyphi-vulgaris**, FL.

JUNIPER, RED-CEDAR (*Juniperus*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, FL, MS.
BLACK MILDEW. **Apiosporium pinophilum**, OR; **Dimerium juniperi**, CA; **Asterina cupressina**.
BLIGHT, Brown Felt. **Herpotrichia nigra**, northern Rockies to Pacific Northwest.
BLIGHT, Leaf. **Chloroscypha juniperina**, IA; **Pestalotia funerea**, secondary; **Cercospora sequoiae** var. **juniperi**, CT, IA, KY, MO, NE, OK, WI; **Exosporium glomerulosum**, NC, SC; **Stigmina juniperina**.
BLIGHT, Nursery, **Phomopsis juniperovora**, MA to FL, KS, MN.
BLIGHT, Tip Dieback. **Sclerophoma pythiophila**, WI.
BLIGHT, Twig. **Phomopsis juniperovora**, VA.

CANKER. **Botryosphaeria stevensii**, IA; **Coryneum cardinale**, CA; **Caliciopsis nigra**, gall, NY.

CANKER, Bark Patch. **Aleurodiscus nivosus**, AL, OR, TX.

DIEBACK, BRANCH. **Diplodia mutila**, PA.

MISTLETOE. **Phoradendron densum** and **P. juniperinum**, widespread.

NEEDLE CAST; Leaf Spot. **Lophodermium juniperinum**, widespread, secondary; **Cylindrocarpon** sp., OR; **Kriegeria** sp., OR.

NEMATODE, Lesion. **Pratylenchus vulnus**, NC.

PARASITE, "False Foxglove". **Aureolaria grandiflora** var. **serrata**, TX.

ROT, Heart. **Fomes juniperinus**, PA to KY, TN; **F. earlei**, Southwest; **F. subroseus**, general; **F. texanus**, AZ, NM, TX.

ROT, Root. **Armillariella mellea**, CA.

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, OK, TX; **Phytophthora cactorum**; **P. citrophthora**, CA; **P. dreschleri**, NC; **P. lateralis**, NC; **P. syringae**, NC.

ROT, Root. **Fomes annosus**, VA.

ROT, Root and Crown. **Phytophthora cinnamomi**, CA; **P. cryptogea**, CA.

ROT, Wood. **Lenzites saepiaria**, occasional; **Coniophora corrugis**, Pacific Northwest; **Daedalea juniperina**, SC to AR.

RUST. **Gymnosporangium bermudianum** (III), gall on stems, Gulf states; **G. bethelii** (III), on stems, ND to OK, NM, WA; 0, I on hawthorn; **G. clavariiforme** (III), gall on stems, ME to AL west to MT; 0, I on *Amelanchier*, chokeberry, quince, pear; **G. clavipes** (III), quince rust, on stems, ME to IL, MT; 0, I on *Amelanchier*, hawthorn, quince, apple; **G. corniculans** (III), gall on stems, ME, MI, NY, WI; 0, I on *Amelanchier*; **G. cornutum** (III), gall on stems, leaves, CO, ME, MI; 0, I on mountain-ash; **G. davisii** (III), leaf gall, ME, WI; 0, I on chokeberry; **G. effusum** (III), gall on stems, NY to SC; 0, I on chokeberry; **G. exiguum** (III), on leaves, CA, OK, TX; 0, I on hawthorn; **G. exterum** (III), gall on stems, KY; 0, I, *Gillenia*; **G. floriforme** (III) gall, on leaves, stems, SC to FL, OK, TX; 0, I on hawthorn; **G. globosum**, hawthorn rust (III); 0, I on hawthorn, apple, pear, mountain-ash; **G. harknessianum** (III), on western juniper; 0, I on *Amelanchier*; **G. inconspicum** (III), CA, CO, UT; 0, I on *Amelanchier*; **G. gracile**, witches' broom (III), 0, I, on sand pear.

RUST, Cedar-Apple. **Gymnosporangium juniperi-virginianae** (III), gall on leaves of red-cedar, prostrate and Rocky Mountain junipers, general; 0, I on apple, crabapple.

RUST. **Gymnosporangium clavipes**, galls on stems, VA; **G. globosum**, gall on stems, VA; **G. exterum**, gall on stems, VA.

RUST. **Gymnosporangium juvenescens** (III), gall on stems, witches' brooms, MN, NE, WI; 0, I on *Amelanchier*; **G. japonicum** (III), CT, MA, NJ, WA; 0, I on *Photinia*; **G. kernianum**, witches' broom, ID, OR to AZ, NM; 0, I on *Amelanchier*, pear; **G. multiporum** (III), CO to NM, CA; 0, I unknown; **G. nelsonii** (III), gall on stems, MT, SD; 0, I on hawthorn, crabapple, mountain-ash, quince, *Amelanchier*; **G. nidus-avis** (III), gall on stems; witches' brooms, East and South; 0, I on *Amelanchier*, apple, hawthorn, mountain-ash, quince; **G. speciosum** (III), on stems, AZ, CO, NV, NM; 0, I on *Fendlera, Philadelphus*; **G. trachysorum** (III), on stems, FL, LA, MS, SC; **G. tremelloides** (III) gall on stems, CO to Pacific Northwest; 0, I on mountain-ash; **G. tubulatum** (III), gall on stems, SD to OR, WA; 0, I on hawthorn; **G. vauqueliniae** (III), on one-seed juniper; 0, I on *Vauquelinia*, causing witches' brooms.

Of this lengthy list of juniper rusts the three common apple rusts are most important in the garden, not so much for the damage to this host as for the harm to the deciduous fruit or ornamental. These three are the cedar-apple rust caused by *Gymnosporangium juniperi-virginianae*, the hawthorn rust by *G. globosum*, and the quince rust by *G. clavipes*. The latter is perennial in juniper and may produce spores each spring for as long as 20 years. Varieties of *Juniperus chinensis* and *J. communis* and some other forms are resistant to cedar-apple and cedar-hawthorn rusts. If you have only a few red-cedars, it is quite feasible to cut out galls in late winter, before spores are produced.

KAGENECKIA

SCAB. **Spilocaea botryae**, CA.

KALANCHOE

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**.

BACTERIAL Wilt and Soft Rot. **Erwinia carotovora** pv. **carotovora**, FL.

BLIGHT, Flower. **Stemphylium bolickii**, FL; **S. floridanum** f. sp. **kalanchoe**, also leaf spot, FL.

LEAF SPOT. **Cercospora** sp., MS.

ROT, Crown, Stem; Wilt. **Phytophthora cactorum**, NJ, NY; **Diplodia natalensis**, AL.
VIRUS. **Mosaic**, FL; **Kalanchoe Latent**; **Kalanchoe Top-Spotting**.

KENTUCKY COFFEE-TREE (*Gymnocladus*)

LEAF SPOT. **Cercospora gymnocladi**, North central states; **Marssonina** sp., Northeast; **Phyllosticta gymnocladi**, IL.
ROT, Root. **Phymatotrichum omnivorum**, OK, TX.
ROT, Wood. **Polyporus pulchellus**, IN, MI.

KERRIA

BLIGHT, Twig. **Phomopsis japonica**, NJ, OH, TX.
CANKER, Coral Spot. **Nectria cinnabarina**, NJ, OR, WA.
LEAF SPOT; Leaf and Twig Blight. **Coccomyces kerriae**, widespread, eastern states to IA and TX; **Septoria** sp., MD, NJ.
ROT, Root. **Phymatotrichum omnivorum**, TX.

KIDNEY VETCH, LADYS-FINGERS (*Anthyllis*)

BLIGHT, Leaf and Stem. **Fusarium** sp., NC.
LEAF SPOT. **Phyllosticta** sp., NC.

KIWI (*Actinidia*)

BACTERIAL Canker. **Pseudomonas syringae**, CA.
NEMATODE, ROOT KNOT. **Meloidogyne incognita**, SC.
ROT, Root and Wilt. **Cylindrocladium crotalariae**, SC; **Pythium ultimum**, AL.

KNIPHOFIA (Tritoma, Torch-Lily, Poker-Plant)

LEAF SPOT. **Alternaria** sp., AL.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.

KNOTROOT BRISTLEGRASS (*Setaria geniculata*)

BLIGHT. **Beniowskia sphaeroidea**, GA.

KOCHIA (Summer-Cypress)

DAMPING-OFF; Root Rot. **Pythium debaryanum**; SD; **Rhizoctonia solani**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia aristidae** (0, I), CO, NE, TX.
VIRUS. **Beet Curly Top**, CA.

KOHLERIA

VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

KRIGIA (Dwarf Dandelion)

DOWNY MILDEW. **Bremia lactucae**, MS, MO, OK WI.
LEAF SPOT. **Mycosphaerella krigiae**, IL, WI; **Septoria krigiae**, KY, NY, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia dioicae** (0, I), IL, IA, WI; II, III on *Carex*; **P. hieracii** (0, I, II, III), NC; **P. maculosa** (III), IL, MI, MS, MO, PA, TN.

KUDZU (*Pueraria*)

BACTERIAL Blight. **Pseudomonas phaseolicola**, CT to FL, LA, IN; **P. syringae**, NY.
BLIGHT, Web. **Pellicularia filamentosa**, GA, MS.
DAMPING-OFF. **Rhizoctonia solani**.
LEAF SPOT. **Alternaria** sp., secondary; **Mycosphaerella puerariicola**, MS, AL, GA.
NEMATODE, Root Knot. **Meloidogyne** spp., general.
ROT, Charcoal. **Macrophomina phaseoli**, GA; stem, **Fusarium** sp., LA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Phakopsora pachyrhizi**, FL, KY, TX.

KUHNIA (False-Boneset)

LEAF SPOT. **Pleospora compositarum**, NM, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia kuhniae** (0, I, II, III), IN to AL, FL, MT, NE, ND, TX.

KUMQUAT (*Fortunella*)

DODDER. **Cuscuta campestris**, FL.
LEAF SPOT. **Cephaleuros virescens**, algal spot, Gulf states; **Phyllosticta citricola**, MS.
NEMATODE, Citrus. **Tylenchulus semipenetrans**, FL.
ROT, Black. **Alternaria citri**; stem-end, **Diaporthe citri**, CA.

LAMIUM (Perennial Groundcover)

NEMATODE, LEAF. **Aphelenchoides fragariae**, CT.

LANTANA

BLACK MILDEW. **Meliola cookeana**, FL.
LEAF SPOT. **Alternaria** sp., TX.
NEMATODE, Leaf. **Aphelenchoides fragariae**, NJ.
NEMATODE, Root Knot. **Meloidogyne** spp., widespread.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia lantanae** (III), FL.
VIRUS. **Tomato Spotted Wilt**, PA.
WILT. **Fusarium** sp., NJ.

LAPPULA (Hackelia)

DOWNY MILDEW. **Peronospora echinospermi**, IA, TX; **P. myosotidis**, MT.
LEAF SPOT. **Cercospora cynoglossi**, WI; **Ovularia asperifolii** var. **lappulae**, WI; **Phyllosticta decidua**, WI, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, IA, MI, MN, MO, OH, TX, WI; **Microsphaera** sp., IL.

ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia mertensiae** (III), TX, UT.
SMUT, Leaf. **Entyloma serotinum**, UT.

LARCH (*Larix*)

BLIGHT, Needle. **Hypodermella laricis**, Great Lakes, Pacific Northwest. **Meria laricis**, ID.
BLIGHT, Seedling. **Thelephora caryophyllea**, ID, MT, girdle, smother; **Rhizina undulata**, ID; **Meria laricis**, WA.
CANKER. **Aleurodiscus amorphus**, bark patch, Northwest; **A. spinulosus**; **A. werii**; **Lachnellula willkommii**, European larch canker, MA, eradicated, ME; **Valsa kunzei** var. **kunzei**.
CANKER. **Phomopsis pseudotsugae** (*Phacidiella coniferarum*) on western larch, Northwest.
DAMPING-OFF. **Rhizoctonia solani**, cosmopolitan.
MISTLETOE, Dwarf. **Arceuthobium campylopodum**, MT to OR, WA; **A. pusillum**, Northeast, MN.
NEEDLE CAST. **Lophodermium** sp., WA; **L. laricinum**, MT to OR; **L. laricis**, ID; **Cladosporium** sp., ME; **Mycosphaerella laricina**, IA, VT, WI.
ROT, Heart. **Echinodontium tinctorium**, WA; **Fomes** spp., widespread.
ROT, Root. **Armillaria mellea**, cosmopolitan; **Phymatotrichum omnivorum**, TX.
ROT, Sapwood. **Lenzites saepiaria**.
ROT, Seedling. **Botrytis douglasii**, gray mold, Northwest; **Cylindrocladium scoparium**, NJ; **Phytophthora cinnamomi**, MD; **Sparassis radicata**, MT to OR, WA.
ROT, Wood. **Polyporus** spp.; **Poria** spp.; **Stereum** spp., widespread.
RUST. **Melampsora paradoxa** (0, I), northern U.S. including AK; II, III on willow; **M. larici-populina** (0, I), Quebec, Canada, WA; II, III on poplar; **M. medusae** (0, I), New England to MI and IN; II, III on poplar; **M. medusae** f. sp. **deltoidea** (0, I), WA; II, III on poplar; **Melampsoridium betulinum** (0, I), CT, WI; II, III on birch.
WOOD DECAY fungi associated with woodpecker nest cavities: **Coniophora puteana**, **Gloeophyllum sepiarium**, **Oligoporus placentus**, **Stereum sanguinolentum**, **Neolentinus lepideus**, **Phaelous schweinitzii**, **Wolfiporia cocos**, OR.

LARKSPUR

(►Delphinium)

Crown Rot, Southern Blight, is prevalent on annual larkspur.

LAUREL

►California-Laurel, ►Cherry-Laurel, ►Mountain-Laurel.

LAUREL, SWEET BAY (*Laurus*)

BLIGHT, Thread. **Pellicularia koleroga**, SC.

LAURESTINUS (*Viburnum tinus*)

DOWNY MILDEW. **Plasmopara viburni**, GA.
LEAF SPOT. **Hendersonia tini**, LA; **Leptosphaeria tini**, LA.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL, LA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
POWDERY MILDEW. **Erysiphe viburni**, CA.
WILT. **Verticillium albo-atrum**, OR.

LAVATERA (Treemallow)

ANTHRACNOSE, Leaf Spot. **Colletotrichum malvarum**, CA, TX.
DAMPING-OFF. **Rhizoctonia solani**, IL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia malvacearum** (III), CA.
VIRUS. **Abutilon Infectious Variegation**.

LAVENDER (*Lavandula*)

BACTERIAL LEAF DISEASE. **Xanthomonas campestris**, CA.
LEAF SPOT. **Septoria lavandulae**, OH, OK.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Root. **Armillaria mellea**, TX.

LAWNS

► Grasses.

LAYIA (Tidy-Tips)

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA.
VIRUS. **Tomato Spotted Wilt**, CA.

LEADTREE (*Leucaena*)

ROT, Root. **Ganoderma sulcatum**, TX.
RUST. **Ravenelia leucaenae** (II, III), TX.

LEATHERWOOD (*Dirca*)

RUST. **Puccinia dioicae** (I), ME to MN, MO, AL; II, III on *Carex*.

LEBBEK (*Albizzia lebbek*)

LEAF SPOT, Algal. **Cephaleuros virescens**, FL.
RUST. **Sphaerophragmium acaciae**, FL.

LEDUM (Labrador-Tea)

GALL, Leaf. **Exobasidium vaccinii**, AK, OR, WA; **Synchytrium vaccinii**, red spot, ME.
LEAF SPOT. **Ascochyta ledi**, WI; **Cryptostictis arbuti**, CA, OR; **Rhytisma andromedae**, tar spot, ID.
POWDERY MILDEW. **Microsphaera alni**, WA.
RUST. **Chrysomyxa ledi** (II, III), CA, CT, ID, MI, MT, NV, NH, NY, WI, WY; **C. ledicola** (II, III), AK, ME, NH, NY, WA, WI; 0, I on spruce.
SPOT ANTHRACNOSE. **Elsinoë ledi**, CA, ME, MI, MN, NY, OR, PA, WA, WI.

LEEK

► Shallot.

LEMON

►Citrus Fruits.

LEMON GRASS, CITRONELLA GRASS (*Cymbopogon*)

LEAF SPOT, Eye-spot. **Helminthosporium sacchari**, FL.
RUST. **Puccinia nakanishikii**, CA.
TANGLE-TOP. **Myriogenospora paspali**, FL.

LENTIL (*Lens*)

ANTHRACNOSE. **Colletotrichum truncatum**, ND.
BACTERIAL, Pink Seed. **Erwinia rhapontici**, Saskatchewan, Canada.
ROT, Root. **Thielaviopsis basicola**, ID, WA; **Pythium irregulare**, WA.
VIRUS. **Red Clover Vein Mosaic**, OR; **virus epidemic**, WA.

LEPTOSPERMUM

ROT, Root. **Armillaria mellea**, CA.

LESPEDEZA

LEAF AND STEM DISEASE. **Cercospora zebrina** (clover isolate), NC.

LETTUCE (*Lactuca*)

ANTHRACNOSE. **Marssonina panattoniana**, NY to FL, CA, MI, OR, TX, WA.
BACTERIAL Leaf Spot. **Xanthomonas campestris** pv. **vitians**, OH.
BACTERIAL Marginal Leaf Blight. **Pseudomonas fluorescens** pv. **marginalis**, KS, MO, NJ, NY; **P. cichorii**, NY.
BACTERIAL, MLO. **Aster Yellows** (white heart, Rio Grande Disease) and **California Aster Yellows**, widespread.
BACTERIAL Rot. **Pseudomonas viridilivida**, DE, LA, MI, NH, NY, VA, WA.
BACTERIAL Soft Rot. **Erwinia carotovora**, cosmopolitan in market.

BACTERIAL Wilt. **Xanthomonas vitians**, NJ, NM, NY, PA, SC, VA.

BLIGHT, Southern. **Sclerotium rolfsii**, CA, FL, NC, SC, TX, VA.

CORKY ROOT. **Rhizomonas suberifaciens**, FL.

DAMPING-OFF; Stump Wilt; Stunt. **Pythium** spp., cosmopolitan.

DOWNY MILDEW. **Bremia lactucae**, general.

LEAF SPOT. **Alternaria** sp., secondary; **Cercospora longissima**, FL, IL, IN, TX, VA, WI; **Septoria lactucae**, occasional in East and central states, to CO, FL, MN.

LEAF YELLOWING; STUNT. **Pythium uncinulatum**, CA.

NECROSIS OF ROOTS, SYSTEMIC. **Plasmopara lactucaeradicis**, hydroponically grown, VA.

MOLD, Leaf; Seed. **Pleospora herbarum**, FL, KY, NY.

NEMATODE. **Naccobus batatiformis**.

NEMATODE, Lesion. **Pratylenchus** sp.

NEMATODE, Root Knot. **Meloidogyne hapla**.

NEMATODE, Sting. **Belonolaimus gracilis**.

NONPARASITIC. **Tipburn**. High temperature and excessive transpiration. **Brown Blight**. Cause unknown, AZ, CA.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, MI.

ROT, Basal. **Phoma exigua**, CA.

ROT, Bottom; Damping-off. **Rhizoctonia solani**, general.

ROT, Watery Soft; Drop. **Sclerotinia sclerotiorum**, widespread; **S. minor**, in transit and market.

ROT, Gray Mold. **Botrytis cinerea**, chiefly in greenhouses, sometimes outdoors.

ROT, Root. **Fusarium** sp., KY, OH; **Phymatotrichum omnivorum**, AZ, TX; **Phytophthora cryptogea**, CA; **Pythium myriotylum**, VI.

RUST. **Puccinia dioicae** (0, I), IN, MN, ND, WI; II, III on *Carex*; **P. hieracii** (II), CA.

SLIME MOLD. **Physarum cinereum**, occasional under glass.

VIRUS. **Cucumber Mosaic**, NY; **Sonchus Yellow Net**, FL; **Tobacco Rattle**, CA; **Lettuce Mosaic**, general; **Radish Yellows**; **Lettuce Big Vein**, associated with *Olpidium brassicae* in roots, FL; **Tomato Spotted Wilt**, CA, HI, TX; **Tobacco Necrosis**; **Lettuce Infectious Yellows**, AZ, CA; **Lettuce Speckles Mottle**, CA; **Tomato Bushy Stunt**, CA; **Tobacco Streak**, FL; **Potato Leafroll**. Pacific Northwest.

WHITE RUST. **Albugo** sp., TX.

WILT, Leaf Blight. **Pythium tracheiphilum**, WI; **Fusarium oxysporum** f. sp. **lactucum**, AZ, CA.

Nonparasitic tipburn is the most general of lettuce diseases, prevalent at high temperatures when soil is deficient in moisture. Some hot weather varieties are rather resistant. Spacing plants well apart in a well-drained soil will reduce bottom rot and drop. Eliminate wild weed hosts and spray for leafhopper vectors to reduce aster yellows.

LEUCOJUM (Snowflake)

LEAF SCORCH, Red Blotch. **Stagonospora curtisii**, CA.
NEMATODE, Meadow. **Pratylenchus** sp.
ROT; Scale Speck, of Bulbs. **Botrytis** sp., CA.

LEUCOSPERMUM

BLIGHT. **Calonectria colhounii**, HI.
WILT. **Verticillium dahliae**, CA.

LEUCOTHOË

BLACK MILDEW. **Asterina diplodioides**, AL.
BLIGHT, Leaf Spot. **Cylindrocladium avesiculatum**, GA.
CANKER, Felt Fungus. **Septobasidium pseudopedicellatum**, FL.
GALL, Leaf. **Exobasidium vaccinii**, MA, MS, NC.
LEAF SPOT. **Cercospora leucothoës**, NJ, NY; **Cryptostictis** sp.; **Guignardia leucothoës**, MD, NC, RI, SC, TN, VA; **Mycosphaerella leucothoës**, NJ; **Phyllosticta terminalis**, NY to FL; **Ramularia andromedae**, NJ; **Rhytisma decolorans**, tar spot, CT, FL, TN, VA. **Pestalotia leucothoës**, NJ.
POWDERY MILDEW. **Microsphaera penicillata**, GA.
SPOT ANTHRACNOSE. **Elsinoë ledi**, FL.

LEWISIA (Bitterroot)

RUST. **Uromyces unitus** (I, III), CA, MT, WA.

LIATRIS (Gayfeather)

DODDER. **Cuscuta glomerata**, OK.
LEAF SPOT. **Phyllosticta liatridis**, WI; **Septoria liatridis**, MN, ND, TX, WI.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Golovinomyces cichoracearum**, OK.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, NY.
RUST. **Coleosporium laciniariae** (II, III), NJ to FL, AR, TX; 0, I on pines; **Puccinia liatridis** (0, I), IN, KS, MT, NE, ND, WI to CO; II, III on grasses.
WILT. **Verticillium albo-atrum**, NJ.

LIGUSTRUM

► Privet.

LILAC (*Syringa*)

ANTHRACNOSE, Shoot Blight. **Gloeosporium syringae**, CT, MA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT.
BACTERIAL Blight; Twig Canker. **Pseudomonas syringae**, northeastern states to AL, IL, Pacific Coast.
BLIGHT, Blossom, Shoot. **Phytophthora cactorum**, IA, MD, MA, MN, NJ; **P. syringae**, MD, NY; **Sclerotinia sclerotiorum**, WA.
BLIGHT, Cutting. **Cylindrocladium scoparium** and **C. floridanum**, FL, OH.
BLIGHT, Gray Mold. **Botrytis cinerea**. Pacific Northwest, Northeast.
BLIGHT, Thread. **Pellicularia koleroga**, FL, MS, NC.
BACTERIAL, Witches Broom. **MLO**, IL.
BLOTCH, Leaf. **Heterosporium syringae**, NJ; **Cladosporium herbarum**, secondary, cosmopolitan.
CANKER; Stem Girdle. **Hymenochaete agglutinans**, CT.
CANKER; DIEBACK. **Physalospora obtusa**, MA to VA, OH.
LEAF SPOT. **Cercospora lilacis**, widespread; **Macrophoma halstedii**, CT, NJ, NY; **Phyllosticta** sp., MA; **Pleospora herbarum**, secondary, MD.
NEMATODE, Citrus. **Tylenchulus semipenetrans**.

NONPARASITIC. **Blight**. Graft incompatibility of lilac scion on privet stock.
POWDERY MILDEW. **Microsphaera alni**, general.
PHYTOPLASMA. **Witches' Broom**, IL; **Ash Yellows**, MD, ND.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Armillaria mellea**, CA, MS; **Thielaviopis basicola**, CT.
ROT, Wood. **Polyporus gilvus**, MD; **Stereum purpureum**, OK.
VIRUS. **Lilac Mottle**; **Lilac Ring Spot**, MI, MN; **Lilac Witches' Broom**, MD.

Powdery mildew is the most general and conspicuous disease of lilacs, but it comes too late in the season to damage the bushes materially. It can be controlled with repeated application of GreenCure, sulfur, or Karathane, where the time and expense are justified. In wet seasons bacterial and Phytophthora blights may be important, but dieback is more often due to borers than to diseases.

LILY (*Lilium*)

BACTERIAL Soft Rot. **Erwinia carotovora**, GA, MA, NJ, WV.
BLIGHT, Botrytis; Leaf Spot. **Botrytis elliptica**, general; **B. cinerea**, general; **B. liliorum**, CA; **Botryotinia sphaerosperma**, CA.
BLIGHT, Bud. **Sporotrichum** sp., secondary, VA.
BLIGHT, Southern; Bulb Rot. **Sclerotium rolfsii**, cosmopolitan.
CANKER, Stem. **Rhizoctonia solani**, CA.
DAMPING-OFF. **Pythium debaryanum**; **Rhizoctonia solani**, cosmopolitan.
LEAF SPOT. **Cercospora** sp., FL; **Cercosporella lilii**, CT, NY; **Ramularia** sp., WA; **Heterosporium** sp., MD.
MOLD, Leaf and Bulb. **Cladosporium** sp., cosmopolitan.
NEMATODE, Leaf; Bunchy Top; Dieback. **Aphelenchoides fragariae**, CA, OR, WA and in greenhouses.
NEMATODE, Lesion. **Pratylenchus pratensis**, **P. penetrans**, Northwest; **P. vulnus**, OR.
NEMATODE, Root Knot. **Meloidogyne** spp., FL.
NONPARASITIC, **Scorch**, of Easter lilies. Acid soil, low fertility, excessive phosphorus.

Bud Blast. Insufficient light; also causes drop of lower leaves. **Chlorosis**. Iron deficiency. Sometimes result of systemic insecticide. **Limber Neck**. Physiological.

ROT, Basal. **Fusarium oxysporum** f. sp. **lilii**, general.

ROT, Black Scale. **Colletotrichum lilii**, LA, MS; Brown Scale, **Colletotrichum** sp., OR, WA; Scale-tip, **Cylindrocarpon radicicola**, secondary.

ROT, Bulb. **Penicillium** spp., blue mold; **Rhizopus** sp., soft rot, cosmopolitan.

ROT, Charcoal. **Macrophomina phaseoli**, CA.

ROT, Root. **Pythium** spp.; **Rhizoctonia solani**, wide spread.

ROT, Stem, Foot. **Phytophthora cactorum**, MD, MN, NJ, NC, NY, OH, WA, WI; **P. parasitica**, top rot, IN, MD, NJ, NY; **Rhizoctonia tuliparum**, WA; **Sclerotinia sclerotiorum**, CT, FL, TX, WA.

RUST. **Puccinia sporoboli** (0, I), NE, ND; II, III on *Sporobolus*; **Uromyces holwayi** (0, I, II, III), ME to NJ, CA, ID, MI, MN, NE, OR, WA.

VIRUS. **Lily Fleck**; **Lily Latent Mosaic**; **Lily Mottle**; **Lily X**, CA; **Lily Ring Spot**; **Lily Rosette**; **Lily Symptomless**, MD; **Cucumber Mosaic**; **Tulip Breaking Mosaic**; **Streak**, on Easter lily, virus from wild cucumber.

VIRUS. **Curl-Stripe Disease**, OR.

Garden lilies are particularly subject to Botrytis blight and mosaic. Madonna lilies are most susceptible, with leaves often completely blackened in wet weather. Copper sprays are perhaps most effective. The only sure way to be free from mosaic and other virus diseases is to grow lilies from seed in an isolated portion of the garden.

LILY-OF-THE-VALLEY (*Convallaria*)

BLIGHT, Gray Mold; Rhizome Rot. **Botrytis paeoniae**, IL, ME, PA.

BLIGHT, Southern. **Sclerotium rolfsii**, ME.

LEAF BLOTCH. **Ascochyta majalis** (*Mycosphaerella convallaris*), PA.

LEAF SPOT. **Gloeosporium convallariae**, NY; **Kabatiella microsticta**, secondary, MD; **Phyllosticta** sp., NJ, NY; **Phytophthora citricola** (also foliar blight), CA.

NEMATODE, Meadow. **Pratylenchus pratensis**, associated with forcing failures.

NEMATODE, Root Knot. **Meloidogyne** sp., occasional.

LINARIA (Blue Toadflax; Butter and Eggs)

ANTHRACNOSE. **Colletotrichum vermicularioides**, MA, NJ, NY, TX, WI.
BACTERIAL, MLO. **Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
DOWNY MILDEW. **Peronospora linariae**, FL, MA, OK, WI.
LEAF SPOT. **Alternaria** sp., MI; **Septoria linariae**, WI.
NEMATODE, Root Knot. **Meloidogyne** spp.
NEMATODE, Stem and Leaf. **Ditylenchus dipsaci**, NY.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, IL; **Thielaviopsis basicola**, CT.
ROT, Stem. **Sclerotinia sclerotiorum**, AZ.
RUST. **Puccinia antirrhini** (II, III), CA; **Aecidium** sp., WI.
SMUT, White. **Entyloma linariae**, CT, NJ, PA.

LINDEN, BASSWOOD (*Tilia*)

ANTHRACNOSE; Leaf Spot. **Gnomonia tiliae** (*Gloeosporium tiliae*), CT to VA, IA, MN.
BLIGHT, Leaf. **Cercospora microsora**, general.
CANKER, Bark. **Aleurodiscus acerinus**; **A. griseo-canus**, IA, MO, PA.
CANKER; DIEBACK. **Botryosphaeria** sp., MD; **Nectria** spp., NY, PA, VA; **Strumella** sp., NJ.
CANKER, Felt Fungus. **Septobasidium fumigatum**, FL.
LEAF SPOT. **Phlyctema tiliae**, NY; **Phyllosticta praetervisa**, WI; **Sphaeropsis** sp., OK.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), South.
POWDERY MILDEW. **Microsphaera alni**, MN; **Phyllactinia corylea**, MN; **Uncinula clintonii**, general.
ROT, Heart. **Daedalea confragosa**, VT; **Fomes** spp.; **Steccherinum septentrionale**, AL, MI; **Pholiota adiposa**, MA, PA, TN.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Ustulina vulgaris**, NY; **Phytophthora dreschleri**, NC.
ROT, Sapwood. **Collybia velutipes**, occasional; **Pleurotus ostreatus**, cosmopolitan.

ROT, Wood. **Daldinia concentrica**, MN, NY; **Lenzites betulina**, NY, VT; **Schizophyllum commune**, MN; **Polyporus** spp.; **Stereum** spp.; **Trametes mollis**, VT.
SOOTY MOLD. **Fumago vagans**.
SPOT ANTHRACNOSE. **Elsinoë tiliae**, VA.
WILT. **Verticillium albo-atrum**, IL.
Anthracnose and Cercospora leaf blight are common diseases.

LINNAEA (Twin-Flower)

BLACK MILDEW. **Halbaniella linnaeae**, NY.
LEAF SPOT. **Phyllachora wittrockii**, tar spot, MI, MT, NM, NY; **Venturia dickei**, ID, MI, MT, NM, NY, OR, WA, WI. **Septoria breviuscula**, NY.

LIONS-EAR (*Leonotis*)

LEAF SPOT. **Cercospora leonotidis**, LA; **Septoria breviuscula**, NY.
RUST. **Puccinia leonotidis** (0, I, II, III), FL.

LIPPIA (Fog-Fruit, Lemon-Verbena)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, AZ.
BLACK MILDEW. **Meliola lippiae**, AZ, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, AZ, CA.
LEAF SPOT. **Cercospora lippiae**, widespread; **Cylindrosporium lippiae**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., AZ.
SPOT ANTHRACNOSE. **Sphaceloma lippiae**, IN, FL.

LIPSTICK VINE (*Aeschynanthus*)

LEAF SPOT. **Corynespora casiicola**, FL; **Myrothecium roridum**, FL.
VIRUS. **Tomato Spotted Wilt**, PA.

LISIANTHUS (*Eustoma grandiflora*)

ROT, Root. **Pythium irregulare**, CA.

LITHOCARPUS (Tanbark Oak)

BLIGHT, Leaf. **Pestalotia castagnei**, CA.
BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, CA. OR.
LEAF SPOT. **Ceuthocarpum conflictum**, CA.
POWDERY MILDEW. **Erysiphe trina**, CA.
ROT, Wood. **Poria** spp.; **Stereum hirsutum**.
RUST. **Cronartium quercuum** (II, III), CA; 0, I on pine.
WILT. **Phytophthora ramorum**, CA, OR.

LITHOPHRAGMA (Woodland-Star)

RUST. **Puccinia heucherae** (III), CA, UT, WA.
SMUT, Leaf and Stem. **Urocystis lithophragmae**, UT.

LITHOSPERMUM (Gromwell, Puccoon)

LEAF SPOT. **Septoria lithospermi**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, PA, TX.
RUST. **Aecidium hesleri**, TN; **Puccinia recondita** (0, I), NE, ND, SD, TX.

LITSEA (Pond-Spice)

LEAF SPOT. **Cercospora olivacea**, GA.

LOBELIA (Cardinal-Flower, Blue Lobelia)

BACTERIAL BLIGHT. **Pseudomonas cichorii**, WA.
BLIGHT, Gray Mold. **Botrytis cinerea**.
DAMPING-OFF. **Pythium debaryanum**, MA, NY.
LEAF SPOT. **Cercospora lobeliae**, AL, IL, IN, KS, MD, TX; **C. effusa**, IA, TX; **Phyllosticta bridgesii**, IN; **Septoria lobeliae**, ME to VA, TX, WI.
NEMATODE, Root Knot. **Meloidogyne** spp., FL, MD, NE, NY.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, NY, OH.
ROT, Stem. **Sclerotium rolfsii**, NJ.
RUST. **Puccinia lobeliae** (III), AR, MI, WI, NY to NC, TX, WA.

SMUT, Leaf. **Entyloma lobeliae**, ME to PA, MO, WI.
VIRUS. **Beet Curly Top**, TX; **Tomato Spotted Wilt**, TX.

LOCUST (*Robinia*)

ANTHRACNOSE; BLACK LOCUST. **Colletotrichum gloeosporioides**, GA, SC.
BACTERIAL, MLO. **Witches'-Broom**, VA.
BLIGHT, Seedling; Leaf. **Alternaria** sp., NC to AL, MO; **Fusicladium robiniae**, MD to AL, MO, WI.
CANKER. **Nectria cinnabarina**, VA.
CANKER; Twig Blight. **Aglaospora anomala**, ME to GA; **Fusarium sarcochroum**, IA; **Diaporthe oncostoma**, NY to GA, IL.
DAMPING-OFF. **Rhizoctonia solani**, ME to AL, NE, TX; **Pythium** spp., NE, TX.
DODDER. **Cuscuta** sp.; **C. arvensis**, widespread.
LEAF SPOT. **Cladosporium epiphyllum**, TN, VA, WV; **Cylindrosporium solitarium**, TX; **Gloeosporium revolutum**, NJ; **Phloeospora robiniae**, NY to OH; **Phyllosticta robiniae**, LA.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, NM, NC, TX; **Viscum album**, CA.
NEMATODE, Lesion. **Pratylenchus** sp., OR.
NEMATODE, Root Knot. **Meloidogyne** spp., OK, TX.
NONPARASITIC **Chlorosis**. Iron Deficiency, NE, TX.
Little Leaf. Zinc deficiency, CA.
POWDERY MILDEW. **Erysiphe polygoni**, CA; **Microsphaera diffusa**, IL, NC; **Phyllactinia corylea**, NM.
ROT, Root. **Armillaria mellea**; **Phymatotrichum omnivorum**, NM, OK; **Pythium myriotylum**, NC; **Fusarium** sp., AL, GA.
ROT, Heart. **Fomes** spp.; **Polyporus** spp.
ROT, Heart. **Fomes rimosus**, VA.
ROT, Seedling Stem. **Phytophthora cinnamomi**, MD; **Rhizoctonia bataticola**, AL, NC; **Sclerotium bataticola**, TX.
ROT, Wood. **Daedalea unicolor**, WI; **Poria** spp.
VIRUS. **Locust Witches' Broom**, Robinia Brooming Disease, PA to GA, AR, OH.
WILT, Seedling. **Phytophthora parasitica**, AL, NC, VA; **Verticillium albo-atrum**, IL.

LOGANBERRY

► Blackberry.

LOMATIUM (Biscuit-Root)

DOWNY MILDEW. **Plasmopara nivea**, MT.
LEAF SPOT. **Phyllachora** sp., WA.
RUST. **Puccinia asperior** (0, I, III), CA, OR, WA; **P. jonesii** (0, I, III), KS, NE, UT, WA; **P. ligustici**, ID, WA.

LOOSESTRIFE, FRINGED (*Steironema*)

LEAF SPOT. **Cylindrosporium steironematis**, NY; **Mycosphaerella** sp., NY; **Phyllosticta lysimachiae**, NY; **Ramularia lysimachiae**, NC, WI; **Septoria conspicua**, ME to MS, CO, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia dayi**, NY to WV, IL, MI, MT, WI; **P. distichlidis** (0, I), CO, ND; II, III on marsh grass; **Uromyces acuminatus** (0, I), CT to CO, ND, SD.

LOOSESTRIFE, MONEYWORT (*Lysimachia*)

BLIGHT, Leaf and Stem Necrosis. **Ceratobasidium anceps**, WI.
GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Cercospora lysimachiae**, NJ; **Cladosporium lysimachiae**, MA; **Ramularia lysimachiae**, WI; **Septoria conspicua**, IA, NY, VT.
NEMATODE, Root Knot. **Meloidogyne** sp., TX.
NEMATODE, Stem. **Ditylenchus dipsaci**.
ROT, Crown Stem. **Sclerotium rolfsii**, KS; **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium campanulae** (II, III), TN; 0, I on red pine; **Puccinia limosae** (0, I), MA to NC, MI, NE, WI.

LOQUAT (*Eriobotrya*)

ANTHRACNOSE; Flower Blight; Withertip. **Colletotrichum gloeosporioides**, CA, FL, TX.

BACTERIAL Fire Blight. **Erwinia amylovora**, Gulf states, AZ, CA.
BLIGHT, Leaf; Blotch. **Fabraea maculata**, FL.
LEAF SPOT. **Phyllosticta eriobotryae**, FL; **Pestalotia** sp., secondary; **Septoria eriobotryae**, FL.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL.
NEMATODE, Burrowing. **Radopholus similis**, FL.
ROT, Collar, Crown. **Phytophthora cactorum**, CA.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
SCAB. **Fusicladium eriobotryae**, on leaves, stems, fruit, Gulf states; **Spilocaea eriobotryae** (*Fusicladium photinicola*).

LOTUS (*Nelumbo*)

BLIGHT. **Dothiorella nelumbonis**, on flower parts, DE, MD.
LEAF SPOT. **Alternaria nelumbii**, MD, NJ, NY, OK, PA, TX; **Cercospora nelumbonis**, IN, TX.

LUCUMA (Canistel, Egg-Fruit)

ANTHRACNOSE; Fruit Spot. **Colletotrichum gloeosporioides**, FL.
CANKER. **Physalospora obtusa**, SC.
RUST. **Achrotelium lucumae** (II, III), FL.

LUDWIGIA (False Loosestrife)

LEAF SPOT. **Cercospora ludwigiae**, AL; **Pezizella oenotherae**, VA; **Phyllosticta ludwigiae**, NY, WI; **Septoria ludwigiae**, MD, MS, PA.
RUST. **Puccinia jussiaeae** (0, I, III), DE to FL, CA, LA, MS, OH, TX, WI.

LUPINE (*Lupinus*)

ANTHRACNOSE. **Colletotrichum trifolii**, NC; **C. fragariae**, NC.
BLIGHT, Gray Mold. **Botrytis cinerea**, MA, MT, NY.

BLIGHT, Leaf. **Hadrotrichum globiferum**, CA, CO, OR, WA, WY.

BLIGHT, Seedling. **Pleiochaeta setosa**, **Alternaria** sp., **Aspergillus flavus**, **Aspergillus niger**, **Curvularia** sp., **Rhizopus stolonifer**.

BLIGHT, Southern. **Sclerotium rolfsii**, probably general.

BLIGHT, Stem Necrosis. **Ascochyta** sp., CT, WI; **Alternaria alternata** (Bluebonnet), TX.

BROWN SPOT. **Pleiochaeta setosa**, Nova Scotia, Canada.

DAMPING-OFF. **Rhizoctonia solani**, CT, TX.

DOWNY MILDEW. **Peronospora trifoliorum**, WI.

LEAF SPOT. **Alternaria** sp., MA; **Cercospora longispora**, FL, MO, NY, WI; **C. lupini**, FL, OR, SC; **C. lupinicola**, TX; **Corynespora cassiicola**, TX; **Cylindrosporium lupini**, CA; **Mycosphaerella pinodes**, WI; **Ovularia lupinicola**, WA; **Phoma lupini**, also stem spot, CO to NM, CA; **Phyllosticta ferax**, CA to WA, WY, SD to CO; **P. lupini**, CA; **Ramularia lupini**, TX; **Septogloeum lupini**, CA, MI; **Septoria lupinicola**, WI; **Stictochlorella lupini**, CA, WA.

LESION, STEM. **Phoma** sp.

NEMATODE, Leaf. **Aphelenchoides ritzemabosi**.

NEMATODE, Lesion. **Pratylenchus pratensis**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

NEMATODE, Sting. **Belonolaimus gracilis**, GA; ring, **Criconema** sp., CA.

POWDERY MILDEW. **Microsphaera** sp.; **Erysiphe polygoni**, widespread; **Ovulariopsis** sp. (Bluebonnets), NM.

ROT, Root. **Armillaria mellea**, CA; **Fusarium** sp., NJ, VA; **Phymatotrichum omnivorum**, TX; **Pythium ultimum**, CA; **Thielaviopsis basicola**, IA, WI.

ROT, Root, Crown, Stem. **Pythium paroecandrum**, NM.

ROT, Stem. **Macrophomina phaseoli**, charcoal rot; **Sclerotinia sclerotiorum**, LA, NY, TX; **Pythium debaryanum**, TX, CA; **Rhizoctonia solani**, Alberta, Canada.

RUST. **Puccinia andropogonis** var. **onobrychidis** (0, I), MI, MN, NY, WI; II, III on *Andropogon*; **Uromyces lupini** (0, I, II, III), CA, MT, NE, OR, WA; **U. occidentalis** (II, III), on native lupine, MT to NM, CA, WA.

SMUT. **Thecaphora deformans**, on seed, CO, WY.

VIRUS. **Bean Yellow Mosaic**, FL; **Bidens Mottle**, FL; **Ring Spot**. Unidentified; **Tomato Spotted Wilt**, TX; **Peanut Mottle**, GA; (Stunt/Vein Clearing) **Tombusvirus**, AK.

WILT. **Sclerotinia minor**, TX.

These diseases are of lupines grown as ornamentals. Lupines as ground covers and soil preservers have their own troubles. In gardens powdery mildew is prevalent, and leaf spots are not often important.

LYCHEE

ROT, Mushroom Rot. **Clitocybe tabescens**, sometimes fatal in FL.

LYCHNIS (Campion)

BLIGHT, Shoot and Flower. **Botrytis cinerea**, AK.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Alternaria dianthi**, AK; **Leptothyrium lychnidis**, AL; **Phyllosticta lychnidis**, IA, TX; **Septoria lychnidis**, MA.
MOLD, Leaf. **Heterosporium** sp., AK.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, IL; **Corticium galactinum**, MD.
ROT, Stem. **Phytophthora cactorum**, IN.
RUST. **Puccinia arenariae** (III), PA; **Uromyces suksdorfii** (I, II, III), UT; **U. verruculosus**, IN, MI, NY, TX.
SMUT, Anther. **Ustilago violacea**, MN, WI, WY.

LYCIUM (Desert-Thorn, Christmasberry)

LEAF SPOT. **Cercospora lycii**, OK.
POWDERY MILDEW. **Arthrocladiella mongeotii**, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Aecidium lycii** (0, I), AZ; **Puccinia globosipes** (II, III), UT to NM, CA; 0, I unknown; **P. tumidipes** (II, III), TX to AZ, UT.

LYCORIS

LEAF SCORCH; Red Spot. **Stagonospora curtisii**, CA.
NEMATODE, Bulb Scale Rot. **Ditylenchus dipsaci**, NC, VA; **Aphelenchoides fragariae**, FL, GA, ND, SD.
NEMATODE, Root. **Hoplolaimus** sp., NC.

LYONIA (Maleberry, Fetterbush, Staggerbush)

BLACK MILDEW. **Asterina lepidigena**, FL; **Lembosia andromedae**, AL; **Morenoella dothideoides**, FL.
BLIGHT, Leaf. **Ramularia cylindriopsis**, ME.
DODDER. **Cuscuta compacta**, FL.
GALL, Leaf; Shoot Hypertrophy. **Exobasidium vaccinii**, MA to FL, AL.
LEAF SPOT. **Ceuthocarpon ferrugineum**, FL; **Pestalotia vaccinii**, secondary; **Septoria pulchella**, GA.
LEAF SPOT, Tar. **Rhytisma andromedae**, widespread; **R. decolorans**, MS.
POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, AL.
ROT, Wood. **Poria versipora**, ME.
RUST. **Pucciniastrum myrtilli** (II, III), DE to AL, AR; 0, I on hemlock.

LYSILOMA

ROT, White Pocket Heart. **Fomes extensus**, FL.
RUST. **Ravenelia annulata** (II, III), FL; **R. lysilomae**, FL.

LYTHRUM (Winged, Purple Loosestrife)

GALL, Leaf. **Synchytrium lythrii**, LA.
LEAF SPOT. **Cercospora lythri**, WI; **C. lythracearum**, MS; **Pezizella oenotherae**, MI, NY; **Septoria lythrina**, KS, NY, WI.
ROT, Root. **Rhizoctonia solani**, IL.

MAACKIA

ROT, Root. **Phymatotrichum omnivorum**, TX.

MACADAMIA

CANKER. **Phytophthora cinnamomi**, CA.

MADRONE (*Arbutus menziesii*)

BLIGHT (Sudden Oak Death). **Phytophthora ramorum**, CA.

CANKER. **Hendersonula toruloidea**, WA; **Fusicoccum** sp., western North America.

CANKER, Trunk. **Phytophthora cactorum**, CA, WA.

GALL, Leaf; Red Leaf Spot. **Exobasidium vaccinii**, CA, OR, TX, WA.

LEAF SPOT. **Ascochyta hanseni**, CA; **Cryptostictis arbuti**, CA, OR; **Didymosporium arbuticola**, OR; **Mycosphaerella arbuticola**, CA, OR, WA; **Phyllosticta fimbriata**, OR.

LEAF SPOT, Tar. **Rhytisma arbuti**, CO, OR, TX, WA.

ROT, Heart. **Fomes subroseus**, OR.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Lenzites saepiaria**, OR, TX; **Polyporus** spp., OR, TX; **Trametes sepium**, CA.

RUST. **Puccinastrum sparsum** (II, III), CA, OR, WA.

SPOT ANTHRACNOSE. **Elsinoë mattirolianum**, CA.

MAGNOLIA

BACTERIAL Leaf Spot. **Pseudomonas syringae**, IL; **P. cichorii**, AL.

BLACK MILDEW. **Dimerosporium magnoliae**, TX; **Irene araliae**, MS; **Meliola amphitricha**, Gulf states; **M. magnoliae**; **Trichodothis comata**, South.

BLIGHT, Seedling. **Rhizoctonia solani**, NJ.

BLIGHT, Thread. **Pellicularia solani**, NJ.

CANKER, Felt Fungus. **Septobasidium langoisii**, **S. tenui**, **S. leprieurii**, Gulf states.

CANKER; Twig Blight. **Nectria** sp., WV; **N. magnoliae**, NJ, TN, WV; **Tubercularia** sp., MI.

LEAF SPOT. **Alternaria tenuis**, TX; **Cladosporium fasciculatum**, GA to TX; **Cercospora magnoliae** (*Mycosphaerella milleri*), FL, NJ, NC, SC, WV; **Cristulariella pyramidalis**; **Colletotrichum** sp., FL, GA, SC; **Coniothyrium** sp., TX; **C. olivaceum**, TX; **Epicoccum nigrum**, TX; **Exophoma magnoliae**, FL, TX; **Glomerella cingulata**, AL, FL, GA, LA, MS, SC, TX; **Hendersonia magnoliae**, VA; **Heterosporium magnoliae**, FL, NC, TX; **Micropeltis alabamensis**, AL; **Phyllosticta**

cookei, NY to Gulf states, CA; **P. magnoliae**, large leaf spot, NY to Gulf states, CA; **Septoria magnoliae**, SC to FL, TX.

LEAF SPOT; Algal; Green Scurf; "Red Rust". **Cephaleuros virescens**, general.

NEMATODE, Burrowing. **Radopholus similis**, FL.

NEMATODE, Citrus. **Tylenchulus semipenetrans**, FL.

NEMATODE, Lance. **Hoplolaimus uniformis**, RI.

NEMATODE, Lesion. **Pratylenchus pratensis**.

NEMATODE, Root Knot. **Meloidogyne** sp.

NEMATODE, Sting. **Belonolaimus longicaudatus**, FL.

PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, Southern U.S., LA.

ROT, Flower. **Ciborinia** (*Sclerotinia*) **gracilipes**, MD.

ROT, Heart. **Fomes fasciatus**; **F. geotropus**.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Clitocybe tabescens**, GA.

ROT, Wood. **Daldinia concentrica**, cosmopolitan; **Polyporus** spp.; **Poria** spp., **Stereum** spp.

SPOT ANTHRACNOSE. **Elsinoë magnoliae**, FL, GA, LA, MS.

WILT. **Verticillium albo-atrum**, CA, IN.

The many leaf spots need not be alarming; they seldom cause premature defoliation. In the Gulf states lichens appear as small round gray spots on leaves, and the parasitic alga *Cephaleuros* often forms a velvety coating with hairlike outgrowths.

MAHOGANY (*Swietenia*)

BLIGHT, Twig, Stem. **Phomopsis** sp., OR.

LEAF SPOT. **Pestalotia swieteniae**, FL; **Phyllachora swieteniae**, FL.

MAHONIA (Oregon-Grape)

CANKER; Leaf Blotch. **Leptosphaeria berberidis**, ID, MD.

LEAF SPOT. **Cercospora** sp., LA; **Gloeosporium berberidis**, WA; **Phomopsis** sp., secondary; **Phyllosticta** spp., AL, CT, WA; **Cylindrocladium** sp., FL, GA.

NEMATODE, Root Knot. **Meloidogyne** sp.

NONPARASITIC. **Scald**. In eastern states winter injury to foliage is severe.

PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, Southern U.S., LA.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Cumminsiella mirabilissima** (0, I, II, III), common Western Great Plains to Pacific Coast; **C. texana**, TX; **C. wootoniana** (II, III), AZ, NM; **Puccinia graminis** (0, I), CA, MI, ND; II, III on cereals and grasses; **P. koeleriae** (0, I), CO, ID, MT, OR; II, III on *Koeleria*; **P. oxalidis** (0, I), NM; II, III on *Oxalis*.

Rust due to *Cumminsiella* is usually inconspicuous, but in a wet season there is a general blighted effect. *Mahonia*, like barberry, is under wheat-rust quarantine. *Mahonia repens* is immune.

MAIANTHEMUM

BLIGHT. **Botrytis** sp., NY.

LEAF SPOT. **Ramularia rubicunda**, MI, NY, OH, PA, WI, CA to AK; **Sphaeropsis cruenta**, AK, WA.

RUST. **Puccinia sessilis** (0, I), MA, MI, MN, NY, PA, WI; II, III on *Phalaris*; **Uromyces acuminatus** var. **magnatus** (0, I), MI, NY, WI; II, III on marsh grass.

MALACHRA

LEAF SPOT. **Cercospora malachrae**, TX.

MALACOTHRIX

GALL, Leaf. **Synchytrium innominatum**, CA.

RUST. **Puccinia harknessii** (III), CA; **P. hieracii** (0, I, II, III), CA.

MALLOTUS

LEAF SPOT. **Cercospora malloti**, MS.

MALLOW, GARDEN (*Malva*)

BACTERIAL, MLO. **California Aster Yellows**, CA; **Beet Curly Top**, CA.

LEAF SPOT. **Alternaria** sp.

ROT, Root. **Macrophomina phaseoli**, CA on *Malva parviflora*.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia heterospora** (III), KS, TX; **P. malvacearum**, CA, CO, OR, WV.
VIRUS. **Malva Vein Clearing**, CA.

MALVASTRUM (False-Mallow, Bush-Mallow)

ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia interveniens** (0, I), CA; III on *Stipa*; **P. malvacearum**; **P. schedonnardi** (0, I), MT, ND to NM; II, III on wild grasses; **P. sherardiana** (0, III), MT, ND to TX, NM; **P. heterospora** (III), TX.
VIRUS. **Begomoviruses** (especially in Malvaceous weed species), Yucatan Peninsula.

MALVAVISCUS

BLIGHT, Twig. **Sclerotinia sclerotiorum**, TX.
LEAF SPOT. **Phyllosticta malvavisci**, TX.
ROT, Root. **Clitocybe tabescens**, FL; **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.
RUST. **Kuehneola malvicola** (II, III), TX; **Puccinia heterospora** (III), TX.

MANFREDA (Spice-Lily, Wild Tuberose)

LEAF SPOT. **Cercospora amaryllidis**, TX; **Phyllosticta hymenocallidis**, TX.
RUST. **Aecidium modestum**, TX.

MANGO (*Mangifera*)

ANTHRACNOSE; Flower and Twig Blight; Fruit Rot. **Glomerella cingulata**, cosmopolitan.
BLIGHT, Twig. **Phomopsis** sp., FL; **Physalospora** (*Diplodia*) spp.
CANKER, Brown Felt. **Septobasidium pilosum** and **S. pseudopedicellatum**, FL.
GALL, ON TREE. **Fusarium decemcellulare**, FL.

LEAF SPOT. **Phyllosticta mortoni**, FL, TX; **Septoria** sp., FL.
LEAF SPOT, Algal, Green Scurf. **Cephaleuros virescens**, general.
NONPARASITIC. **Little Leaf**. Zinc deficiency, FL.
Soft Nose. On Indian varieties.
POWDERY MILDEW. **Oidium mangiferae**, CA, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Root and Crown. **Phytophthora palmivora**, AZ.
ROT, Stem-end Fruit. **Diplodia** sp.
SOOTY MOLD. **Capnodium** spp., general.
SPOT ANTHRACNOSE; Mango Scab. **Elsinoë mangiferae**, FL.
WILT. **Verticillium albo-atrum**, FL.

MANGROVE (*Rhizophora*)

LEAF SPOT. **Cercospora rhizophorae**, FL.

MANIHOT (Cassava, Manioc)

ANTHRACNOSE; Withertip. **Gloeosporium manihotis**, FL, LA, TX.
DIEBACK. **Physalospora abdita** and **P. rhodina**, FL.
LEAF SPOT. **Cercospora henningsii**, FL, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, FL.
VIRUS. **Cassava Common Mosaic**, FL.

MANZANITA (*Arctostaphylos*)

BLACK MILDEW. **Meliola** sp., CA.
BLIGHT (Sudden Oak Death). **Phytophthora ramorum**, CA.
GALL, Red Leaf Spot. **Exobasidium vaccinii**, widespread; shoot gall, **E. vaccinii-uliginosi**, CA, OR.
LEAF SPOT. **Cryptostictis arbuti**, OR; **Phyllosticta amicta**, CA, OR.
MISTLETOE. **Phoradendron villosum**, CA, OR.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Root and Crown. **Phytophthora cinnamomi**, CA.
ROT, Wood. **Fomes annosus**, CA; **F. arctostaphyli**, and **F. igniarius**, general; **Poria ferruginosa**.
RUST. **Pucciniastrum sparsum** (II, III), CA, OR.

MAPLE (*Acer*)

ANTHRACNOSE; Leaf Blight. **Discula campestris**, WI; **Gloeosporium apocryptum**, large blotches, general; **G. acerinum**, small spots; **G. saccharinum**; **G. aceris**.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MI, OK, TX, VA.

BACTERIAL Leaf Scorch. **Xylella fastidiosa**, KY.

BACTERIAL Leaf Spot. **Pseudomonas aceris**, on Japanese maple, CA; **P. acernea**.

BLIGHT, Inflorescence. **Ciborinia acerina**, MA, NY.

BLIGHT, Leaf. **Didymosporina aceris**, CT, PA.

BLIGHT, Seedling; Smother. **Thelephora albido-brunnea**, NC, VA.

BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, CA.

BLIGHT, Twig. **Macrophoma** sp., AR, NY.

CANKER, Bark. **Aleurodiscus acerinus**, MA, VT; **Hymenochaete agglutinans**, CT, MI, MT.

CANKER, Basal, Crown. **Phytophthora cinnamomi**, NJ; **P. cambivora**, NJ.

CANKER, Bleeding. **Phytophthora cactorum**, CT, MA, NJ, NY, RI,VA.

CANKER; DIEBACK. **Colletotrichum acutatum**, on Japanese maple, CT; **Coniothyrium negundinis**, IL, OK; **Cytospora** spp., MI; **Eutypella parasitica**, MI, MN, NH, NY, VT, WI; **Hypoxylon morsei**, MI, MN; **Fusarium** spp.; **Nectria cinnabarina**, cosmopolitan, often secondary; **N. coccinea**; **N. galligena**, widespread trunk canker; **Phomopsis** sp., OH; **P. acerina**, NY; **Physalospora** spp., secondary; **Sphaeropsis albescens**, IL, IA, KS, NY, ND, SD, WI; **Strumella coryneoidea**, MI, PA; **Schizoxylon microsporum**, Lake states; **Stegonsporium acerinum**, NJ.

CANKER, Felt Fungus. **Septobasidium** spp., AL, FL, KY, LA, NC, SC, TN, VA.

DAMPING-OFF. **Rhizoctonia solani**, cosmopolitan.

DODDER. **Cuscuta gronovii**, on seedlings, NY.

LEAF BLISTER. **Taphrina carveri**, AL, KY, MI, MO; **T. bartholomaei**, UT; **T. darkeri**, OR; **T. dearnessii**, black, GA, MI, MN, NC, NY, OK, PA, VA; **T. sacchari**, on sugar maple, AR, GA, IN, KS, ME, MI, MO, NH, NY, OH, PA, TN, WV, WI.

LEAF SPOT. **Actinopelte dryina**, IL; **Alternaria** sp., secondary; **Cercospora negundinis**, KS, NE, WI; **C. saccharini**, MA; **Cercosporella**

aceris, WA; **Cristulariella depraedens**, CT, NY; **C. pyramidalis**, FL; **Monochaetia desmazierii**, GA, NC, OK, TN; **Illosporium maculicola**, WA; **Laestadia brunnea**, NC, SC; **Leptothyrella acerinum**, OK; **Marssonina truncatula**, OR; **Pezizella oenotherae**, NY, NC, VA; **Phyllosticta minima**, eyespot, general; **P. negundinis**, ME to AL, TX, WI; **Piggotia negundinis**, leaf blotch, WI, WY; **Stilbella acerina**, PA; **Septoria aceris**, general; **Venturia acerina**, NY, PA, VA, WV, WI.

LEAF SPOT, Tar. **Rhytisma acerinum**, general; **R. punctatum**, speckled, general.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), common from NJ to FL, MO, TX.

MISTLETOE. **Viscum album** on Big Leaf Maple (*Acer macrophyllum*) and Silver Maple (*A. saccharinum*), CA.

NEMATODE. **Criconemoides** sp.; **Hemicycliophora** sp.; **Pratylenchus sp. thornei**; **Tylenchorhynchus** sp.; **Xiphinema** sp.

NEMATODE, Root Knot. **Meloidogyne** sp., OR; **M. ovalis**, WI.

NONPARASITIC. **Leaf Scorch**. Common on street and lawn trees, associated often with high temperature after a moist spring.

Decline. Frequently roadside salt injury.

Frost Crack. Gas Injury.

PARASITIC LICHEN. **Strigula elegans** and **S. camplanata**, Southern U.S., LA.

POWDERY MILDEW. **Phyllactinia corylea**, CA, IA, NC, OR, SD, VT; **Uncinula circinata**, ME to AL, MI, MO, TX; **Microsphaera alni**; **Sawadaea bicornis**, ID, WA; **S. tulasnei**, NY, Montreal, Canada.

ROT, Heart, Sapwood, Wound. **Collybia velutipes**, CT, MA; **Daedalea** spp., northeastern and north central states, southward; **Daldinia concentrica**, cosmopolitan; **Fomes applanatus**; **F. connatus**; **F. igniarius**; **Ganoderma lucidum**, fatal to some street trees, NJ, NY; **Hericium erinaceous**, VT to MD, MI, MN; **Lenzites** spp.; **Pholiota adiposa**; **Pleurotus** spp.; **Polyporus** spp.; **Poria** spp.; **Steccherinum septentrionale**, general; **Stereum** spp.; **Schizophyllum commune**, cosmopolitan; **Ustulina vulgaris**, northeastern and north central states; **Valsa leucosomoides**, on tapped sugar maples.

ROT, Root. **Armillaria mellea**, general; **Clitocybe tabescens**, GA, MO; **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.

ROT, Sapstreak. **Endoconidiophora virescens**; **Ceratocystis coerulescens**.

ROT, Seedling, Charcoal. **Macrophomina phaseoli**, IL.

VIRUS. **Peach Rosette**; **Tobacco Necrotic Ring Spot**.

WILT. **Verticillium albo-atrum**, widespread in cultivated trees, especially Norway maple.

Verticillium wilt is the most destructive maple disease and is particularly prevalent in street trees. The wilting may be confined to a single branch, which can be cut out, or may kill the whole tree. In removing dead trees, get all of the root system and replace with a different kind of tree. Leaf scorch is common on sugar maple in hot, windy weather; anthracnose may be conspicuous in wet weather.

MARAH

VIRUS. **Wild Cucumber Mosaic**, CA, OR.

MARANTA (*Calathea*)

LEAF SPOT. **Glomerella cincta**, NJ; **Phyllosticta** sp., NJ; **Drechslera setariae**, FL.

RUST. **Puccinia cannae** (II, III), FL.

MARGUERITE (*Argyranthemum frutescens*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, IA, MD, NJ, NY, VA.

BACTERIAL, MLO. **Aster Yellows**, KS, NJ, NY, and **California Aster Yellows**, CA.

DOWNY MILDEW. **Peronospora radii**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp.

POWDERY MILDEW. **Golovinomyces cichoracearum**, NJ.

VIRUS. **Beet Curly Top**, CA.

WILT. **Verticillium albo-atrum**, NJ.

MARIGOLD (*Tagetes*)

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **tagetis**, NC.

BACTERIAL, MLO. **Aster Yellows**, CT, NJ, NY, PA, WI; **California Aster Yellows**, CA.

BACTERIAL Wilt. **Pseudomonas solanacearum**, FL.
BLIGHT. **Alternaria tagetica**, SC.
BLIGHT, Head. **Botrytis cinerea**, AK, CT, NJ, PA; **Helminthosporium** sp., TX.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, NJ, VA.
LEAF SPOT. **Alternaria tagetica**, SC, NJ; **Cercospora** sp., CT, **C. tageticola**, FL; **Septoria tageticola**, FL.
NEMATODE. **Aphelenchoides tagetae**, MD; **Paratylenchus micoletzkyi**, MD.
NEMATODE, Root Knot. **Meloidogyne hapla**, VA.
NONPARASITIC Air Pollution. **NO_2**, **SO_3**, **O_3**, NC.
ROT, Charcoal. **Macrophomina phaseoli**, OK.
ROT, Root. **Pythium ultimum**, CA; **Rhizoctonia solani**, TX.
ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, NY; **Phytophthora cryptogea**, NY; **Fusarium** sp., CA, NJ, NY.
RUST. **Coleosporium madiae** (II, III), CA; 0, I on pine; **Puccinia tageticola** (II, III), TX.
VIRUS. **Cucumber Mosaic**, FL.
WILT. **Fusarium oxysporum** f. sp. **callistephi**, CA; **Verticillium albo-atrum**, NY; **V. dahliae**, AZ.

Marigolds are easy to grow without paying too much attention to disease. Cut fading flower heads off into a paper bag before the gray mold of Botrytis blight gets started.

MARIPOSA-LILY, GLOBE-TULIP (*Calochortus*)

RUST. **Puccinia calochorti** (0, I, III), CA, OR, WA to NE, NM.

MARSHELDER (*Iva xanthifolia*)

DOWNY MILDEW. **Plasmopara halstedii**, ND.

MARSH-MARIGOLD (*Caltha*)

GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Cercospora calthae**, WI; **Cylindrosporium** sp., NY; **Fabraea rousseauana**, CA, WI; **Ramularia calthae**, NY, WI.

POWDERY MILDEW. **Erysiphe polygoni**, MI, OH, WI.
RUST. **Puccinia areolata** (0, I, II, III), AK, CA, CO, WA; **P. calthae** (0, I, II, III), NY, NJ to IA, ND; **P. calthicola** (0, I, II, III), NY to IA, MN; **P. gemella** (III), AK, CA, ID, MT, OR, WA; **P. treleasiana** (III), CO, NV, UT, WA, WY.

MATELEA

PARASITIC LICHEN. **Strigula elegans**; **S. complanata**, Southern U.S., LA.

MATRICARIA (False Chamomile)

BACTERIAL, MLO. **California Aster Yellows**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, WA; **Sphaerotheca macularis**, WA.
WHITE RUST. **Albugo tragopogonis**, CA, ND, OR.

MATRIMONY-VINE (*Lycium halimifolium*)

LEAF SPOT. **Alternaria** sp., IA; **Cercospora lycii**, IA; **Phyllosticta lycii**, NY, OH.
POWDERY MILDEW. **Erysiphe polygoni**, CT, DE, MD, NJ, PA; **Microsphaera diffusa**, OH, PA, UT; **Sphaerotheca pannosa**, ID, WA.
RUST. **Puccinia tumidipes** (II, III), NY to AL, SD, TX; **P. globosipes** (II, III), PA.

MAURANDYA

LEAF SPOT. **Septoria antirrhinorum**, TX.

MAURITIUS-HEMP (*Furcraea*)

NEMATODE, Root Knot. **Meloidogyne** sp., MD.

MAY-APPLE (*Podophyllum*)

BLIGHT, Gray Mold. **Botrytis cinerea**, NJ.
BLIGHT, Leaf. **Septotinia podophyllina**, DE, MD, MO, NJ, NY, VA, WV.
LEAF SPOT. **Cercospora podophylli**, IL; **Glomerella cingulata**, DE; **Pezizella oenotherae**, VA; **Phyllosticta podophylli**, NY to AL, AR, WI; **Vermicularia podophylli**, TX, VA.
ROT, Stem. **Rhizoctonia** sp., MO.
RUST. **Puccinia podophylli**, general.

MEADOW-BEAUTY (*Rhexia*)

LEAF SPOT. **Cercospora erythrogena**, AL, DE, MS, TN; **Colletotrichum rhexiae**, DE; **Phyllosticta rhexiae**, FL.

MEADOW-RUE (*Thalictrum*)

DOWNY MILDEW. **Phytophthora thalictri**, CT, NY, WI.
LEAF SPOT. **Ascochyta clematidina** f. sp.**thalictri**, WI; **Cercospora fingens**, IL, WI; **Cercosporella filiformis**, WI; **Cylindrosporium thalictri**, IN, KS, WI; **Gloeosporium thalictri**, WI; **Mycosphaerella thalictri**, NJ, NY, VT, WI; **Septoria thalictri**, KS.
POWDERY MILDEW. **Erysiphe polygoni**, MA to PA, IL, ND.
RUST. **Puccinia recondita** (0, I), CO, MI, northeastern and North central states; II, III on grasses; **P. septentrionalis** (0, I), CA, CO, IN, IA; II, III on *Polygonum*, **Tranzschelia pruni-spinosae** (0, I), CO, IN, IA, KS, NE, ND, OH, PA, SD; II, III on *Prunus*, **T. thalictri** (0, III), eastern and central states to CA, ID, MS, NM.
SMUT, Leaf and Stem. **Urocystis sorosporioides**, AZ, MA, NY, UT.
SMUT, White. **Entyloma thalictri**, CT, IL, IN, NY, WI.

MEADOWSWEET (*Filipendula*)

LEAF SPOT. **Cylindrosporium** sp.; **Septoria ulmariae**, CT.
POWDERY MILDEW. **Sphaerotheca macularis**, IN, NY, VT.
RUST. **Triphragmium ulmariae** (0, I, II, III), IN.

MEDICAGO (Black Medic)

POWDERY MILDEW. **Oidium** sp., CA; **Erysiphe pisi** (on alfalfa), ID, OR.
ROT, Root. **Aphanomyces eutiches**, Race 2 (on alfalfa, IL; **Phoma sclerotioides**, WI.
VIRUS. **Tomato Ringspot**, VT.

MEDLAR (*Mespilus*)

BACTERIAL Fire Blight. **Erwinia amylovora**, NY.
LEAF SPOT. **Fabraea maculata**, CA.
RUST. **Gymnosporangium clavipes**, NY.

MELAMPODIUM (*Melampodium divaricatum*)

POWDERY MILDEW. **Oidium** sp., LA.
VIRUS. **Tomato Spotted Wilt**, LA.

MELALEUCA

RUST. **Puccinia psidii**, FL; **Uromyces striatus** (on sweetclover), KS.

MELILOTUS

BROOMRAPE. **Orobanche ramosa**, TX.
POWDERY MILDEW. **Oidium** sp., KS.
VIRUS. **Sweet Clover Latent**, IL.

MELON, MUSKMELON, CANTALOUPE, CASSABRA (*Cucumis melo*)

ANTHRACNOSE. **Colletotrichum lagenarium**, general in East and South to AZ, CO, ND; **Marssonina melonis**, NY.
BACTERIAL Angular Leaf Spot. **Pseudomonas lachrymans**, CA, DE, IA, MD, MI, NJ, PA; **P. pseudoalcaligenes** subsp. **citrulli**, GA.
BACTERIAL FRUIT BLOTCH. **Acidovorax avenae** (syn. **Pseudomonas pseudoalcaligenes** subsp. **citrulli**, TX.

BACTERIAL Rind Necrosis. **Erwinia** sp., GA, TX.

BACTERIAL Soft Rot. **Erwinia aroideae** and **E. carotovora**.

BACTERIAL Wilt. **Erwinia tracheiphila**, general east of Rocky Mts.; AZ to ID, WA.

BLIGHT, Gummy Stem; Black Rot. **Mycosphaerella citrullina** (*M. melonis*), DE, FL, MA, NJ, NY, TX.

BLIGHT, Leaf; Black Mold. **Alternaria cucumerina**, general.

BLIGHT, Stem Gumming and Stem-End Rot. **Diplodia natalensis**, TX.

BLIGHT, Southern. **Sclerotium rolfsii**, VA and OH to FL, TX.

DAMPING-OFF. **Rhizoctonia solani**, CA, GA, NJ; fruit rot, FL, TX; **Pythium debaryanum**, CA, CT, IA, NJ, NY; **Fusarium equiseti**, CA.

DECAY, Postharvest. **Epicoccum nigrum**, OK.

DODDER. **Cuscuta arvensis**, MD.

DOWNY MILDEW. **Pseudoperonospora cubensis**, general.

LEAF SPOT. **Cercospora** sp., CO, GA, TX; **Phyllosticta** sp., GA, OH, TX; **Septoria cucurbitacearum**, DE, MA, MI, NH, NY, PA, VT, WI.

LEAF SPOT, STEM NECROSIS, MELON NECROTIC SPOT VIRUS, Mexico, Guatemala, Honduras, Panama, and Uraguay.

NEMATODE, Root Knot. **Meloidogyne arenaria**, **M. hapla**, NJ to FL, CA.

NONPARASITIC. **Leaf Spot**. Magnesium deficiency, NY.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general.

ROT, Charcoal. **Macrophomina phaseoli**, CA, OR, TX.

ROT, Corky dry. **Fusarium semitectum**, FL.

ROT, Fruit. **Fusarium** spp., general in market, also **Alternaria** spp.; **Monilia sitophila**, IN, NY; **Mucor** sp., NY; **Penicillium** spp., blue mold; **Phytophthora** spp.; **Rhizopus stolonifer**, cosmopolitan; **Trichoderma viride**, green mold; **Trichothecium roseum**, pink mold, occasional in market.

ROT, Root. **Monosporascus cannonballus** and **Acremonium** sp., CA; **Phymatotrichum omnivorum**, TX; **Pythium periplocum**, CA.

ROT, Root; Cottony Leak. **Pythium aphanidermatum**, AZ, CA, TX.

ROT, Stem. **Sclerotinia sclerotiorum**, AR, MA, TX; **Cephalosporium** sp.

SCAB. **Cladosporium cucumerinum**, occasional, East and central states.

VIRUS. **Beet Curly Top**, AZ, CA, ID, OR, TX, WA; **Cucumber Mosaic**, general; **Muskmelon Mosaic**, general; **Tobacco Ring Spot**, KS, MD, NC, PA, WI; **Squash Mosaic**; **Watermelon Mosaic**; **Zucchini Yellow Mosaic**, CA, FL, NY; **Lettuce Infectious Yellows**, AZ, CA, TX; **Muskmelon Vein Necrosis**, CA; **Melon Necrotic Spot**; **Melon**

Leaf Curl, CA; **Papaya Ring Spot**, LA; **Watermelon Mosaic**, LA; **Cucurbit Leaf Curl**, AZ, TX; **Cucurbit Yellow Stunting**, TX.

WILT. **Fusarium oxysporum** f. sp. **melonis**, general Race 1 Colima, Mexico; **Verticillium albo-atrum**, CA, OR.

Melons belong to the cucurbit family and in general have the same diseases as cucumbers. Downy mildew is a problem on the moist East Coast, and powdery mildew may be a limiting factor in the arid Southwest. Although there are varieties resistant to powdery mildew, different physiological races of the fungus keep things complicated. Sulfur dust should not be used except on sulfur-resistant melon varieties. Mosaic is transmitted both by seed and aphids; purchase virus-free seed, eliminate weeds, and keep down insects.

MELOTHRIA

DOWNY MILDEW. **Pseudoperonospora cubensis**, GA, OH, TX.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

POWDERY MILDEW. **Golovinomyces cichoracearum**, WI.

MENTZELIA (Blazing Star)

LEAF SPOT. **Phyllosticta mentzeliae**, KS, TX; **Septoria mentzeliae**, KS, TX, WA.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, NJ.

RUST. **Puccinia aristidae** (0, I), AZ, CO; II, III on grasses; **Uredo floridana**, FL.

MENZIESIA

GALL, Leaf. **Exobasidium vaccinii**, Pacific Northwest, AL, NC, VA, WV.

LEAF SPOT, Tar. **Melasmia menziesii**, MT, and WY to AK, OR; **Rhytisma** sp.

POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, AK, VA.

RUST. **Pucciniastrum myrtilli** (II, III), WV; 0, I on hemlock.

MERTENSIA (Bluebells, Virginia Cowslip)

DOWNY MILDEW. **Peronospora** sp., MT.

LEAF SPOT. **Septoria poseyi**, OR.

POWDERY MILDEW. **Golovinomyces cichoracearum**, AL, CO, MT, PA, NV, NM, UT, WY.
ROT, Stem. **Sclerotinia sclerotiorum**, CO.
RUST. **Puccinia mertensiae** (III), CO, NV, UT, WY; **P. recondita** (0, I), ID, MT, OR; II, III on grasses.
SMUT, Leaf. **Entyloma serotinum**, IN, IA, MD, VA, WY.
VIRUS. **Cucumber Mosaic**, IL, NJ.

MESEMBRYANTHEMUM (Fig-Marigold)

NEMATODE, Root Knot. **Meloidogyne** sp., AL, TX.
SOOTY MOLD. **Torula herbarum**, CA.

MESQUITE (*Prosopis*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, TX.
BLIGHT, Leaf. **Cercospora prosopidis**; **Scleropycnium aureum**, AZ, TX.
LEAF SPOT. **Napicladium prosopodium**, TX; **Phyllosticta juliflora**, also pod spot, OK, TX; **Gloeosporium leguminum**, pod spot, TX.
MISTLETOE. **Phoradendron californicum**; **P. serotinum** (**flavescens**), TX to CA, and **P. tomentosum**, TX.
POWDERY MILDEW. **Leveillula taurica**; **Oidiopsis taurica**; **Uncinula prosopodis**, TX.
ROT, Heart. **Polyporus texanus**, CA, TX; **Fomes everhartii**, AZ, TX; **Schizophyllum commune**, TX; **Hypoxylon diatrypeoides** (dieback, trunk rot), Mexico.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Ravenelia arizonica** (II, III), TX to CA; **R. holwayi** (0, I, II, III), TX to CA.

MIGNONETTE (*Reseda*)

DAMPING-OFF, Root Rot. **Rhizoctonia solani**, CT.
LEAF SPOT. **Cercospora resedae**, MA to MS, IA, MO.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
WILT. **Verticillium albo-atrum**, NY.

MILK THISTLE (*Silybum*)

VIRUS. **Tobacco Streak**, CA.

MIKANIA (Climbing Hempweed)

LEAF SPOT. **Cercospora mikaniae**, MS; **Septoria mikanii**, CT, TX.
RUST. **Puccinia spegazzinii**, AL, FL, MS, NC.

MILKWORT (*Polygala*)

ANTHRACNOSE. **Gloeosporium ramosum**, IN, NJ, WI.
LEAF SPOT. **Cercospora grisea**, MS, NJ, VA; **Septoria consocia**, IN, MI; **S. polygalae**, NY.
RUST. **Aecidium renatum**, NM; **Puccinia andropogonis** var. **polygalina** (0, I), IA, MI, WI; II, III on *Andropogon*; **P. pyrolae** (III), CT, ME, MI, NH, NY, WI.

MIMOSA, SILK-TREE (*Albizzia julibrissin*)

CANKER; DIEBACK. **Nectria cinnabarina**, DC, NC, VA.
NEMATODE, Root Knot. **Meloidogyne arenaria** var. **thamesii**; **M. incognita**; **M. javanica**; **M. hapla**.
NEMATODE, Stubby Root. **Trichodorus primitivus**.
ROT, Heart. **Ganoderma lucidum**; Root, **Armillaria mellea**.
VIRUS. **Mimosa Striped Chlorosis**, AR.
WILT. **Fusarium oxysporum** f. sp. **perniciosum**, AL, AR, CA, GA, FL, MS, NJ, NC, SC, VA.
The mimosa wilt is one of the most devastating tree disease on record. The fungus is in the soil with no possibility of control by aerial spraying. The incidence of wilting is probably increased by nematodes. Resistant varieties Tryon and Charlotte have been released, but occasional specimens succumb to wilt. The fungus may also be seed-transmitted.

MIMULUS (Monkey-Flower)

BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.

LEAF SPOT. **Cercospora mimuli**, MO; **Ramularia mimuli**, CA, NY, OH, WY; **Septoria mimuli**, PA to MS, MO, NE.

NEMATODE, Leaf. **Aphelenchoides ritzemabosi**.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, PA, UT.

RUST. **Puccinia andropogonis** (0, I), MO, WI; II, III on *Andropogon*; **Uredo** sp. (II), WI.

MINT (*Mentha*)

ANTHRACNOSE. **Colletotrichum coccodes**, WA, WI.

CANKER, Stem. **Fusarium** sp., MI, WA; **Alternaria** sp., MI; **Phoma menthae**, OR.

LEAF SPOT. **Cercospora menthicola**, IL, TX; **Phyllosticta decidua**, occasional, ME to OH, IA, WI; **Ramularia menthicola**, CA, ME, MT, OR; **Septoria menthae** (*S. menthicola*), IN, WI.

NEMATODE. **Aphelenchoides parietinus**; **Paralongidorus sylphus**, OR; **Paratylenchus macrophallus**, OR.

NEMATODE, Root Knot. **Meloidogyne hapla**, OR.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CO, IA, UT, WA; **Erysphie galeopsidis**, IA; **Erysphie orontii**, CA; **Erysiphe polygoni**, TX; **Sphaerotheca macularis**, WA.

RUST. **Puccinia menthae** (0, I, II, III), East and central states to TX and Pacific Coast, FL; **P. angustata** (0, I), CA, SD, WI; II, III on grasses.

SPOT ANTHRACNOSE. **Sphaceloma menthae**, IN, MD, MI.

VIRUS. **Tobacco Ring Spot**, IN; **Tomato Spotted Wilt**, OR; **Strawberry Latent Ringspot**, OR; **Mint Crinkle**.

WILT. **Verticillium albo-atrum** f. sp. **menthae** (*V. dahliae*), IN, MI, OR.

Rust is serious in mints grown commercially, in greenhouses or in the field. Overwintering spores can be killed by treating rhizomes with hot water. Spot anthracnose is largely controlled by thorough coverage when mint is plowed under in the fall. Mint in the backyard is too prolific for worry about disease.

MISCANTHUS

BLIGHT **Leptosphaeria** sp. , MD.

MISTLETOE (*Phoradendron*)

BLACK MILDEW. **Asterina phoradendricola**, FL.
BLIGHT, Brown Felt. **Herpotrichia juniperi**, CA.
BLIGHT, Leaf. **Sphaeropsis visci**, SC, TX; **Phyllosticta phorodendri**, CA.
BLIGHT, Twig. **Nectria cinnabarina**, TX.
CANKER. **Cystospora pinicola**, OR, WA; **Hymenochaete agglutinans**, AL.
CANKER, Felt Fungus. **Septobasidium pseudopedicellatum**, FL.
DODDER. **Cuscuta exaltata**, TX.
LEAF SPOT. **Cercospora struthanthi**, FL; **Exosporium phoradendri**, TX.
RUST. **Peridermium bethelii**, CO; **Uredo phoradendri**, CA, OR.
If you treasure mistletoe for Christmas greens, you will be sorry it has diseases; but if you consider mistletoe a pest, you'll wish the above list were longer.

MISTLETOE, DWARF (*Arceuthobium* spp.)

BLIGHT, Brown Felt. **Herpotrichia juniperi**, CA.
RUST. **Peridermium bethelii**, CO.
SPOT, SHOOT, LESION. **Colletotrichum gloeosporioides**.

MOCK-CUCUMBER (*Echinocystis*)

ANTHRACNOSE. **Colletotrichum lagenarium**, FL.
DOWNY MILDEW. **Plasmopara australis**, IA, KS, MN, OH, WI; **Pseudoperonospora cubensis**, OH.
LEAF SPOT. **Cercospora echinocystis**, NY to FL, NE, WI; also fruit spot; **Septoria** spp., widespread; **Alternaria** sp., FL.
POWDERY MILDEW. **Golovinomyces cichoracearum**, WI.
VIRUS. **Beet Curly Top**, CA; **Cucumber Mosaic**, CA, CO, IL, IN, MI, NY, WI.
WILT. **Fusarium** sp., FL.

MOCK-ORANGE (*Philadelphus*)

BACTERIAL Blight. **Pseudomonas syringae**, MN.

BLIGHT, Flower and Shoot. **Botrytis cinerea**, cosmopolitan.
BLOTCH, Sooty, **Sarcinella heterospora**, FL.
LEAF SPOT. **Ascochyta philadelphi**, NY; **Cercospora angulata**, MO, TX; **Ramularia philadelphi**, TX, WA; **Septoria philadelphi**, ID, IA, MT.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Phyllactinia corylea**, GA, MT, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Gymnosporangium speciosum** (0, I), CO, NM, UT; III on juniper.

MOCK-STRAWBERRY (*Duchesnea*)

DOWNY MILDEW. **Peronospora potentillae**, NC.
GALL, Leaf. **Synchytrium globosum**, SC.
LEAF SPOT. **Pezizella oenotherae**, VA.
RUST. **Frommeella duchesneae** (0, I, II, III), NH to FL, KY; **Frommeella duchesneae**, IN.

MONARDA (Horse-Mint, Bee-Balm)

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
GALL, Leaf. **Synchytrium holwayi**, IA, WI.
LEAF SPOT. **Cercospora** sp., OK; **Phyllosticta decidua**, KS, NE, OK, TX, WI; **P. monardae**, KS; **Ramularia brevipes**, AL, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
RUST. **Puccinia angustata** (0, I), NE, WI; **P. menthae** (0, I, II, III), general from ME to MS. ID,TX, **P. monardae**.
VIRUS. **Mosaic**. Unidentified, IN; **Tomato Spotted Wilt**, PA.

MONARDELLA

LEAF SPOT. **Phyllosticta monardellae**, CA.
RUST. **Puccinia menthae** (0, I, II, III), CA, NV, NM, OR, UT.

MONESES (Wood-Nymph)

RUST. **Chrysomyxa pirolata** (II, III). AK, CO, ME, MI, MT, NM, WA, WY; 0, I on spruce.

MONKSHOOD, ACONITE (*Aconitum*)

BACTERIAL Leaf Spot. **Pseudomonas delphinii**, ME, NJ.
DOWNY MILDEW. **Plasmopora pygmaea**, AK.
NEMATODE, Root Knot. **Meloidogyne** sp., NY, VT.
POWDERY MILDEW. **Erysiphe polygoni**, NY, TX, WV.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, CT, NJ.
ROT, Stem. **Sclerotinia sclerotiorum**, CO; **Sclerotium rolfsii**, CT, DE, MN, NJ, NY.
RUST. **Puccinia recondita** (0, I), CO, AK; II, III on grasses; **Uromyces lycoctoni** (0, I, II, III),CA, CO, TX, UT, WY.
SMUT, Leaf and Stem. **Urocystis carcinodes**, UT; **U. sorosporioides**, UT.
VIRUS. **Mosaic**, Unidentified, NY.
WILT, **Verticillium albo-atrum**, MA, NJ, NY, OH.
Verticillium wilt is doubtless more widespread in monkshood than the official reports indicate. The leaves dry along the stem, flowers are poor, and when the stem is cut across, blackened bundles are readily seen. The clumps do not die immediately but decline over a period of years.

MONKSHOOD VINE (*Ampelopsis aconitifolia*)

DIEBACK. **Tubercularia nigricans**, NH, TX.
NEMATODE, Dagger. **Xiphinema index**.

MONSTERA

ANTHRACNOSE. **Gloeosporium** sp., WA; **Colletotrichum** sp.
LEAF SPOT. **Macrophoma philodendri**, FL, MI.

MONTIA (Indian Lettuce)

SMUT, Seed. **Ustilago claytoniae**, WA.

MOONFLOWER (*Calonyction*)

LEAF SPOT. **Phyllosticta** sp., NJ.

NEMATODE, Leaf. **Aphelenchoides fragariae**, NJ.
NEMATODE, Root Knot. **Meloidogyne** sp., NJ, SC.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium ipomoeae** (II, III), AL, NC, SC, TX; 0, I on pine.
WHITE RUST. **Albugo ipomoeae-panduratae**, FL.

MOONSEED (*Menispermum*)

LEAF SPOT. **Cercospora menispermi**, NY to VA, KS, WI; **Colletotrichum sordidum**, WI; **Phyllosticta menispermicola**, IL; **Septoria abortiva**, IL, KS.
POWDERY MILDEW. **Microsphaera alni**, widespread.
SMUT, Leaf. **Entyloma menispermi**, PA to VA, KS, ND.

MOREA

RUST. **Puccinia iridis**, FL.

MORINDA (Royoc, Indian-Mulberry)

LEAF SPOT. **Cercospora morindicola**, FL.
SPOT ANTHRACNOSE. **Sphaceloma morindae**.

MORNING-GLORY (*Ipomoea*)

BLIGHT. **Phytophthora ipomoeae**, Mexico (Metepec).
BLIGHT, Blossom, Blight. **Choanephora compacta**, GA.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
BLIGHT, Thread. **Pellicularia koleroga**, FL.
CANKER, Stem. **Vermicularia ipomoearum**, NY, PA; **Diaporthe phaseolorum** var. **cauliflora**, LA.
CHLOROTIC LEAF DISTORTION. **Fusarium lateritium**, NC.
LEAF SPOT. **Alternaria** sp., VA; **Cercospora alabamensis**, AL, FL, NJ; **Phyllosticta ipomoeae**, FL, KS, MS; **Septoria convolvuli**, FL, KS, PA, TX, WI.

NEMATODE, Root Knot. **Meloidogyne** sp.; **M. hapla**, AL, OK; **M. incognita**, LA.

NEMATODE. **Rotylenchulus reniformis**, LA.

ROT, Root. **Erwinia carotovora** subsp. **carotovora**, LA; **Phymatotrichum omnivorum**, TX; **Macrophomina phaseolina**, AZ; **Streptomyces ipomoea**, LA; **Ceratocystis fimbriata**, LA; **Fusarium oxysporum** f. sp. **batatas**, LA; **Plenodomus destruens**, LA; **Monilochaetes infuscans**, LA.

RUST. **Puccinia crassipes** (I, III), FL, GA, LA, SC; **Coleosporium ipomoeae** (II, III), NJ to FL, KS, TX; 0, I on pine; **Uredo laeticolor** (II), FL.

VIRUS. **Cucumber Mosaic**, FL; Sweet Potato; **Tomato Spotted Wilt – Impatiens Serotype** and **Lettuce Serotype**, FL; **Sweetpotato Feathery Mottle**.

WHITE RUST. **Albugo ipomoeae-panduratae**, NJ to AZ, NE.

WILT. **Fusarium** sp., TX.

MOSS ROSE (*Portulaca grandiflora*)

VIRUS. **Alternanthera Mosaic**, FL, MD, PA.

MOTHERWORT (*Leonurus*)

BLACK MILDEW. **Dimerosporium hispidulum**, TX.

LEAF SPOT. **Ascochyta leonuri**, LA; **Phyllosticta decidua**, OH, TX, WI; **Septoria lamii**, PA.

VIRUS. **Mosaic**. Unidentified, IN.

MOUNTAIN-ASH (*Sorbus*)

BACTERIAL Fire Blight. **Erwinia amylovora**, widespread, VA.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, NJ.

BLIGHT, Leaf. **Fabraea maculata**, AK, MN, WV, WI.

BLIGHT, Twig. **Nectria cinnabarina**, corla spot, AK, NC; **Phomopsis** sp., MA; **Valsa leucostoma**, OH, WV.

CANKER. **Cytospora** sp., VA.

CANKER, Blister. **Nummularia discreta**, IA, MA.
CANKER, Branch; Fruit Rot. **Glomerella cingulata**, IN.
CANKER; DIEBACK. **Cytospora chrysosperma**, MN, MT, NE, NJ, WA; **C. leucostoma**, MT; **C. massariana**, ID; **C. microspora**, MT; **Fusicoccum** sp., IL.
CANKER, Trunk; Black Rot. **Cytospora rubescens**, IA; **Physalospora obtusa**, IN, MI, OH, CT to VA.
LEAF SPOT. **Alternaria** sp., IA; **Graphium sorbi**, NY, WI; **Phyllosticta globigera**, ID, WA; **P. sorbi**, IL, IA, ME, MO, OK, TX; **Septoria sorbi**, IA; **S. sitchensis**, ID.
MISTLETOE, European. **Viscum album**, CA.
POWDERY MILDEW. **Podosphaera oxyacanthae** var. **tridactyla**, WA.
ROT, Heart. **Polyporus hirsutus**, MI, WA; **P. versicolor**, WI.
ROT, Root. **Armillaria mellea**, NJ; **Phymatotrichum omnivorum**, TX.
RUST. **Gymnosporangium cornutum** (0, I), ME to NJ, WI, MT to CO, AK, WA; III on juniper; **G. globosum** (0, I), OR; III on *Libocedrus*; **G. nelsonii** (0, I), MT, WA, WY; III on juniper; **G. nootkatense** (0, I), AK, OR, WA; III on *Chamaecyparis*; **G. tremelloides** (0, I), MT to CO, AK, WA.
SCAB. **Venturia inaequalis**, IL, MN, NY, WA.

Mountain-ash is quite susceptible to fire blight, but affected branches can usually be pruned out. Rust may appear on foliage in midsummer. If the mountain-ash is more desirable than the junipers nearby, the latter can be eradicated. Fertilizing will help the tree recover from a bout with Cytospora canker but may increase susceptibility to fire blight.

MOUNTAIN-HEATHER (*Phyllodoce*)

BLIGHT, Brown Felt. **Herpotrichia nigra**, ID.
GALL, Leaf. **Exobasidium vaccinii-uliginosi**, OR.

MOUNTAIN-HOLLY (*Nemopanthus*)

LEAF SPOT. **Ramularia nemopanthus**, NY.
LEAF SPOT, Tar. **Rhytisma ilicis-canadensis**, ME to WV, MI.
POWDERY MILDEW. **Microsphaera alni**, NY, WI.
ROT, Wood. **Poria inermis**, PA.

MOUNTAIN-LAUREL (*Kalmia*)

BACTERIAL LEAF SPOT. **Pseudomonas syringae**, OR.
BLIGHT, Flower. **Ovulinia azaleae**, AL, SC, AL.
BLIGHT, Leaf. **Phomopsis kalmiae**, NY to NC.
CANKER; Felt Fungus. **Septobasidium** sp., AL, TX.
GALL, Leaf. **Exobasidium vaccinii**, AK; **Synchytrium vaccinii**, red spot, NJ.
HEART, Rot, Wood Rot. **Fomes annosus**, NC.
LEAF SPOT. **Cercospora kalmiae**, CT to AL, TN; **Mycosphaerella colorata** (*Phyllosticta kalmicola*), CT to AL, IN, MI, TX; **Pestalotia kalmicola**, secondary, DE, NJ, PA, TX, WA; **Septoria angustifolia**, MA to AL, OH; **Rhytisma andromedae**, tar spot, VT.
NONPARASITIC. **Chlorosis**. Usually iron deficiency.
POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, WI.
ROT, Root. **Armillaria mellea**, MD; **Corticium galactinum**, MD; **Phymatotrichum omnivorum**, TX; **Phytophthora lateralis**, NC; **P. cinnamomi**, VA; **P. palmivora**, VA.
ROT, Wood. **Polyporus versicolor**, VA; **Stereum rameale**, VA.
VIRUS. **Rhododendron Necrotic Ringspot**, OR.
Phomopsis leaf blight or blotch and Mycosphaerella (Phyllosticta) leaf spot are common and rather disfiguring on bushes in shade or under tree drip. In light cases, removal of spotted leaves is sufficient.

MOUNTAIN-MAHOGANY (*Cercocarpus*)

LEAF SPOT. **Septogloeum cercocarpi**, CA.
ROT, Wood. **Stereum hirsutum**, OR.
SPOT ANTHRACNOSE. **Sphaceloma cercocarpi**, CA.

MOUNTAIN-MINT (*Pycnanthemum*)

GALL, Leaf. **Synchytrium cellulare**, WI.
LEAF SPOT. **Cercoseptoria blephiliae**, WI; **Cercosporella pycnanthemi**, AL.
RUST. **Puccinia angustata** (0, I), IN; **P. menthae** (0, I, II, III), MA to VA, AL, CA, IA, OK, TX.

MOUNTAIN-SORREL (*Oxyria*)

RUST. **Puccinia oxyriae** (II, III), AK, CA, CO, ID, OR, UT; 0, I unknown.
SMUT, Floral. **Ustilago vinosa**, AK, CA, CO, WA, WY.

MULBERRY (*Morus*)

BACTERIAL Scorch. **Xylem limiting bacteria**, Mid-Atlantic and Southern U.S; **Xylella fastidiosa**, CA.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, NE.
BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **mori**, general.
BLIGHT, Berry; Popcorn Disease. **Ciboria carunculoides**, NC to FL, TX, VA.
BLIGHT, Twig. **Myxosporium diedickei**, TX, WA.
CANKER; Twig Blight. **Cytospora** sp., NJ, TX; **Dothiorella** sp.; **D. mori**, NJ, TX; **Gibberella baccata** var. **mori**, widespread; **Nectria** sp., widespread; **N. cinnabarina**, wide spread; **Sclerotinia** sp., TX.
LEAF SPOT. **Cercospora moricola**, PA to FL, NE, TX; **Cercosporella mori**, NE, OK, TX; **Exosporium** sp., FL; **Mycosphaerella arachnoidea**, false mildew, GA, NC; **M. mori**, widespread; **Phyllosticta moricola**, KS; **Cytospora** sp., VA.
NEMATODE, Root Knot. **Meloidogyne** spp., NJ, NC, OK.
POWDERY MILDEW. **Phyllactinia corylea**, OH; **Uncinula geniculata**, NY to KS, AL.
ROT, Heart. **Polyporus farlowii**, AZ, NM; **P. hispidus**, CT; **Ganoderma applanatum**; **Hymenochaete agglutinans**, MD.
ROT, Root. **Armillaria mellea**, DE, NC, OK; **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Schizophyllum commune**, CA; **Stereum cinerescens**, MA.
RUST. **Cerotelium fici** (II), LA.
Bacterial leaf spot damages nursery trees having overhead irrigation; Mycosphaerella leaf spot sometimes defoliates older trees.

MULLEIN (*Verbascum*)

DOWNY MILDEW. **Peronospora sordida**, NJ.
LEAF SPOT. **Cercospora verbasicola**, TX; **Phyllosticta verbasicola**, IN,

KS, TX; **Ramularia variabilis**, NY to MS, TX, WA; **Septoria verbasicola**, TX, NY to AL, MO, TX.

NEMATODE, Root Knot. **Meloidogyne** sp.

POWDERY MILDEW. **Golovinomyces cichoracearum**, PA; **Oidium** sp., NJ.

ROT, Root, **Phymatotrichum omnivorum**, TX.

VIRUS. **Tomato Ringspot**, VT.

MUSHROOM, OYSTER (*Pleurotus*)

DRY BUBBLE. **Verticillium fungicola**, PA.

MUSK-ROOT (*Adoxa*)

GALL, Leaf. **Synchytrium anomalum**, IA.

LEAF SPOT. **Phyllosticta adoxae**, CO.

RUST. **Puccinia adoxae** (III), CO, UT, WY; **P. argentata** (0, I), IA, MN, WI; II, III on *Impatiens*.

MUSTARD GREENS (*Brassica juncea*)

BACTERIAL Black Rot. **Xanthomonas compestris**, FL, OH.

BACTERIAL, MLO. **Aster Yellows**.

BACTERIAL, Yellows. **Spiroplasma citri**, IL.

CLUB ROOT. **Plasmodiophora brassicae**, CA, CT, OH, TX, WA.

DAMPING-OFF. **Rhizoctonia solani**, cosmopolitan.

DOWNY MILDEW. **Peronospora parasitica**, CT, FL, IA, TX.

LEAF SPOT. **Cercospora brassicicola**, IN, LA, NJ; **Cercosporella brassicae**, CA, VA; **Alternaria brassicae**, CA, black spot; **Pseudocercosporella capsellae**, CA, white spot.

NEMATODE, Root Knot. **Meloidogyne** sp., FL, MO, TX; **Heterodera schachtii**, UT.

POWDERY MILDEW. **Erysiphe polygoni**, AZ, CA, FL, TX.

ROT, Crown; Drop. **Sclerotinia sclerotiorum**, TX.

ROT, Root; Damping-off. **Aphanomyces raphani**, WI.

RUST. **Puccinia aristidae** (0, I), CO; II, III on grasses.

VIRUS. **Cauliflower Mosaic**; **Turnip Mosaic**; **Tobacco Stread**, CA.

WILT. **Fusarium** sp.

MYRTLE (*Myrtus*)

LEAF SPOT. **Pestalotia decolorata**, LA.
ROT, Stem. **Sclerotium rolfsii**, FL.
ROT, Root. **Cylindrocladium pauciramosum**, CA.
RUST, **Puccinia vincae**, CA.

NANDINA

ANTHRACNOSE. **Glomerella cingulata**, TX.
LEAF SPOT. **Cercospora nandinae**, AL, SC.
NEMATODE, Root Knot. **Meloidogyne** sp., NC, TX.
NONPARASITIC. **Chlorosis**. Alkaline soil, TX.
POWDERY MILDEW. **Microsphaera berberidis** (**Erysiphe berberidis**), CA, Pacific Northwest.
ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Cucumber Mosaic**, MD, GA; **Nandina Mosaic**, CA; **Nandina Stem Pitting**, FL.

NARCISSUS (Daffodil, Jonquil)

BACTERIAL Streak; Stem rot. Unidentified, WA.
BLIGHT, Leaf; Fire. **Sclerotinia** (*Botrytis*) **polyblastis**, OR, WA; **Botrytis cinerea**; **Botryotinia polyblastis**, WA.
LEAF SCORCH. **Stagonospora curtisii**, general, especially in East and South.
LEAF SPOT, Blight; White Mold. **Ramularia vallisumbrosae**, OR, WA.
NEMATODE, Bulb. **Aphelenchoides fragariae**, FL, GA, NC, SC; **A. subtenuis**, Pacific Coast; **Aphelenchus avenae**, secondary.
NEMATODE, Bulb; Brown-ring Disease; Leaf "Spikkel". **Ditylenchus dipsaci**, in all commercial narcissus areas.
NEMATODE, Lesion. **Pratylenchus pratensis**, OH, WA.
ROT, Basal. **Fusarium oxysporum** f. sp. **narcissi**, general on hardy varieties.
ROT, Black Bulb. **Sclerotinia sclerotiorum**; crown; wet scale, **Sclerotium rolfsii**, CA, FL, NY, VA.
ROT, Large Scale Speck. **Stromatinia narcissi**, general in northern bulb areas.

ROT, Leaf and Stem. **Gloeosporium** sp., LA, NC.

ROT, Neck; Smoulder. **Sclerotinia narcissicola**, NJ, NY, OR, VA, WA; probably general except on polyanthus varieties.

ROT, Root and Bulb. **Armillaria mellea**, CA, OR, WA; **Aspergillus** spp., black mold; **Penicillium** spp., blue mold, in wounds; **Trichoderma viride**, green mold in scales, cosmopolitan after sunscald; **Rhizopus stolonifer**, soft rot, cosmopolitan after sunscald; **Cylindrocarpon radicicola**, secondary root rot.

ROT, Small Scale Speck; Neck Rot. **Sclerotium** sp., general, especially in southern bulb districts.

VIRUS. **Narcissus Mosaic**, mild; **Narcissus Flower Streak**; **Narcissus Chocolate Spot**; **Narcissus Yellow Stripe**, Gray Disease, often called Mosaic, general; **White Streak**, general.

Control of narcissus diseases rests with the grower, who should, and usually does, supply the gardener with sound, healthy bulbs. Inspect all bulbs carefully before planting, making sure there are no dark sclerotia on the scales or the chocolate brown of Fusarium rot at the base. The bulb and stem nematode is controlled by treating in hot water.

NASTURTIUM (*Tropaeolum*)

BACTERIAL Fasciation. **Clavibacter fascians**, CA.

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **aptata**, ME, MN, MS, NJ, PA, VA.

BACTERIAL, MLO. **California Aster Yellows**, CA.

BACTERIAL Wilt. **Pseudomonas solanacearum**, FL, MD, NJ, NC, VA.

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.

DODDER. **Cuscuta** sp., MO, NH.

LEAF SPOT. **Cercospora tropaeoli**, AL; **Heterosporium tropaeoli**, CA, NY; **Pleospora** sp., MS, NJ, OH.

NEMATODE, Root Knot. **Meloidogyne** spp., NJ, TX; **Heterodera schachtii**, root gall.

RUST. **Puccinia aristidae** (0, I), UT; II, III on grasses.

VIRUS. **Beet Curly Top**, CA, TX; **Tomato Spotted Wilt**, CA, MD, TX.

Compared with the almost inevitable affliction of black aphids, nasturtium diseases are insignificant.

NECTARINE (*Prunus persica* var. *nectarina*)

BACTERIAL Canker. **Pseudomonas syringae**, CA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MO.
BACTERIAL Leaf Spot; Canker. **Xanthomonas pruni**, OK.
BACTERIAL, MLO. **Peach X-Disease**.
CANKER. **Valsa leucostoma**, DC.
LEAF CURL. **Taphrina deformans**, CA, OR, TX, WA.
LEAF SPOT. **Cristulariella pyramidalis**, FL.
LEAF SPOT; Shot Hole. **Coryneum carpophilum**, CA, OR, WA.
NEMATODE, Lesion. **Pratylenchus thornei**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA; usually resistant.
POWDERY MILDEW. **Podosphaera oxyacanthae**, ID, WA; **Sphaerotheca pannosa**, ID, NY, WA.
ROT, Brown; Twig Blight. **Monilinia laxa**, CA, WA; **M. fructicola**, CT, NY, TX.
ROT, Pink Mold. **Trichothecium roseum**, CA.
ROT, Sour. **Geotrichum candidum**, CA; **Issatchenkia scutulata**, CA; **Kloeckera apiculata**, CA.
SCAB. **Cladosporium carpophilum**, CT, DE, IL, NY, PA, TX.
VIRUS. **Peach Mosaic**; **Peach Yellows**; **Peach Latent Mosaic Viroid**, WA; **Hop Stunt Viroid**, Ontario, Canada.

NEMATANTHUS

LEAF SPOT. **Myrothecium roridum**, FL.
VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA.

NEMESIA

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.

NEMOPHILA (Baby Blue-Eyes)

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, NV, TX, WA.

NEPHTHYTIS

LEAF SPOT. **Cephalosporium cinnamomeum**, FL, MD.
NEMATODE, Root Knot. **Meloidogyne incognita**.
ROT, Root. **Pythium splendens**, FL.
VIRUS. **Tomato Spotted Wilt**, PA.
Spraying with maneb should control the leaf spot.

NERINE (Guernsey-Lily)

LEAF SCORCH; Red Blotch. **Stagonospora curtisii**, CA.
NEMATODE, Lance. **Hoplolaimus coronatus**, NC.

NETTLE (*Urtica, Urera*)

NEMATODE, Soybean Cyst.

NEW ZEALAND FLAX (*Phormium tenax*)

ROT, Root. **Armillaria mellea**, CA.

NEW ZEALAND SPINACH (*Tetragonia*)

BACTERIAL, MLO. **Aster Yellows**, NJ, NY.
LEAF SPOT. **Cercospora tetragoniae**, IN, MA; **Helminthosporium** sp., TX.
NEMATODE, Root Knot. **Meloidogyne** sp., TX.
VIRUS. **Beet Curly Top**, CA; **Mosaic**, DE, and **Rosette**, IN, unidentified.

NICOTIANA (Flowering Tobacco)

BACTERIAL Blackfire. **Pseudomonas tabaci**, WI; **P. angulata**, WI.
BLACK SHANK. **Phytophthora parasitica** var. **nicotianae**, CT.
BLIGHT. **Phytophthora infestans**, NY.
DAMPING-OFF, STEM LESIONS. **Rhizoctonia solani**, GA.
DOWNY MILDEW. **Peronospora tabacina**, CA, TX.

LEAF SPOT. **Alternaria longipes**, TX; **Rhizoctonia solani**, NC; **Alternaria alternata**, CT, MA.
MOLD, Blue. **Peronospora tabacina**, GA.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
NEMATODE STUNT. **Globodera tabacum solanacearum**, VA, (also CT and Quebec, Canada on **Nicotiana tobacum**).
POWDERY MILDEW. **Oidium** sp., KY.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium myriotylum**, SC; in hydroponic.
STUNT. **Glomus macrocarpum**, KY.
VIRUS. **Beet Curly Top**, TX; **Tomato Spotted Wilt**, TN, TX, Impatiens and Lettuce serotypes, GA; **Tobacco Mosaic**, GA; **Tobacco Ring Spot**; **Tobacco Vein-Mottling**, NC; **Cucumber Mosaic**, FL; **Tobacco Mild Green Mosaic**, **Tobacco Vein-Banding Mosaic**, TN; **Tobacco Yellow Net**, CA; **Potato Leafroll**, Pacific Northwest, **Potato Virus A**, WA; **Blueberry Scorch**, British Colombia; **Rhynchosia Golden Mosaic**, Mexico; **Potato Virus Y**, GA.
WILT. **Pythium aphanidermatum**, NC.

NIGHT-BLOOMING CEREUS (*Hylocereus*)

VIRUS. **Cactus Virus X**, CA.

NIGHTSHADE, Silverleaf (*Solanum elaeagnifolium*)

Weed found in dry, open woods, prairie, waste places, and disturbed soil in Southwest, U.S.
NEMATODE, Foliar. **Nothanguina phyllobia**, TX.
VIRUS. **Tomato Spotted Wilt**, CA.

NIGHTSHADE, HAIRY AND CLIMBING (*Solanum sarachoides, S. dulcamara*)

BLIGHT. **Phytophthora infestans**, ME, NY.
VIRUS. **Potato Leafroll**, Pacific Northwest.

NINEBARK (*Physocarpus*)

LEAF SPOT. **Cercospora spiraea**, IN; **Marssonina neilliae**, CA, TX, WI; **M. lonicerae**, OR; **Phyllosticta opulasteris**, ID; **Ramularia spiraeae**, MI, NY, WI.
POWDERY MILDEW. **Sphaerotheca macularis**, MA to WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Fomes conchatus**, NY.

NOTHOSCORDUM (False Garlic)

ANTHRACNOSE. **Colletotrichum circinans**, OK.
RUST. **Uromyces hordeinus** (0, I), KS, OK, TX; II, III on grasses; **U. primaverilis** (0, I, III), IL, MO, TX.
VIRUS. **Nothoscordum Mosaic**, LA.

NUTSEDGE (*Cyperus rotunders*)

BLIGHT, Flower. **Balansia cyperi**, LA.
LEAF SPOT. **Dactylaria higginsii**, FL; **Sclerotinia minor**, NC.
NEMATODE, Cyst. **Heterodera mothi**, GA.
NEMATODE, Root-knot. **Meloidogyne graminicola**, GA.
ROT, ROOT. **Pythium arrhenomanes**, LA.
RUST. **Puccinia canaliculata**, GA.
VIRUS. **Impatiens Necrotic Spot Phytoplasma**, GA.

NYMPHOIDES (Floating-Heart)

RUST. **Puccinia scirpi** (0, I); II, III on *Scirpus*, FL.
SMUT, Leaf. **Burrillia decipiens**, NJ.

OAK (*Quercus*)

ANTHRACNOSE; Leaf and Twig Blight. **Gnomonia quercina** (**Gloeosporium quercinum**), general.
BACTERIAL Canker. Unidentified, IL.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD, MI.

BACTERIAL Drippy Nut. **Erwinia quercina**, CA, on live oak.

BACTERIAL Leaf Scorch. **Xylella fastidiosa**, DC, FL, GA, KY.

BACTERIAL Wetwood. **Erwinia nimipressuralis**, VA.

BLACK MILDEW. **Morenoella quercina**, SC to FL, GA, TX; **Irenina manca**, MS.

BLIGHT, Sudden Oak Death. **Phytophthora ramorum**, (also branch canker) CA, OK.

BLIGHT, Twig. **Cryptocline cinerescens**, CA; **Diplodia longispora**, NY to NC, IL, WI; **D. quercina**, CA; **Discula quercina**, CA.

CANKER, Bark. **Aleurodiscus oakesii**, NY to IL, CA, IA; **A. candidus**; **A. acerinus**; **A. griseo-canus**; **Dichaena quercina**, NJ.

CANKER, Basal. **Cryphonectria parasitica**, PA.

CANKER, Bleeding. **Phytophthora cactorum**, FL, MA, NY; **P. cinnamomi**, FL.

CANKER, Branch. **Endothia gyrosa**, VA.

CANKER, Branch; Decline; Dieback. **Botryodiplodia gallae**, MI; **Cephalosporium** sp.; **Hyalodendron** sp.

CANKER, Chestnut. **Endothia parasitica**, MS, SC, VA.

CANKER, Felt Fungus. **Septobasidium** spp., NC to FL, LA.

CANKER, Trunk. **Nectria galligena**; **Strumella coryneoides** (*Urnula craterium*).

CANKER, Twig. **Cytospora chrysosperma**, NJ, RI; **Endothia parasitica**, occasional; **Dothiorella quercina**, MD, VA; **Fusarium solani**; **Physalospora glandicola**, MD; **P. obtusa**, MN, VA; **P. rhodina**, VA; **Pseudovalsa longipes**; **Pyrenochaete venuta**; **Coryneum japonicum**, FL.

DECLINE. **Hypoxylon atropunctatum**, **H. punctulatum**, **H. mediterraneum**, VA.

DODDER. **Cuscuta** spp., occasional in forest nurseries.

LEAF BLISTER. **Taphrina caerulescens**, Northeast to North central and Gulf states; also CA, CO, GA, UT, WY.

LEAF SPOT. **Actinopelte dryina**, occasional; **Acantharia echinata**, black, on live oak; **Cercospora macrochaeta**, CA; **Cylindrosporium microspilum**, **C. kelloggii**, CA; **Ciborinia** (*Sclerotinia*) **candolleana**; **C. hirtella**; **Dothiorella phomiformis**, widespread; **Gloeosporium septorioides**; **Marssonina martini**, general; **Leptothyrella californicum**, on live oak, CA; **Monochaetia desmazierii**, widespread; **Mycosphaerella** sp; **Phyllosticta** spp.; **Septogloeum defolians**, CA; **S. querceum**, WI; **Septoria** spp.; **Venturia orbicula**, NY to VA, OH.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), NC to FL, TX; **P. villosum**, CA.; **P. tomentosum**, TX; **Psittacanthus macrantherus**, Sinaloa, Mexico.

MOLD, Leaf. **Cladosporium brevipes**; **C. herbarum**.

NEMATODE, Dagger. **Xiphinema americanum**, Southeast.

NEMATODE, Ring. **Criconemoides annulatum**; **C. teres**; **Hemicriconemoides biformis**.

NEMATODE, Root. **Hoplolaimus coronatus**; **Pratylenchus** sp.; **Meloidogyne** sp.

NONPARASITIC **Chlorosis**. Iron deficiency, especially in pin oaks.

PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, Southern U.S., LA.

POWDERY MILDEW. **Erysiphe trina**, witches' broom, on live oak, CA; **Microsphaera alni**, widespread; **Phyllactinia corylea**, widespread; **Sphaerotheca lanestris**, "brown mildew," serious on coast live oak, AL, CA, MS, NC; **Saccardia quercina**, AZ, GA.

ROT, Heart. **Daedalea quercina**, widespread, other species; **Fistulina hepatica**; **Fomes** spp.; **Hericium erinaceous**; **Polyporus** spp.; **Stereum** spp.

ROT, Heart. **Phlebia chrysocrea**, eastern U.S. (PA to FL) and WI to MS.

ROT, Root. **Armillaria mellea**, widespread; **Clitocybe tabescens**, FL, MO, OK; **C. olearia**, CA; **Corticium galactinum** and other spp.; **Phytophthora cinnamomi**, of seedlings.

ROT, Root and Collar. **Phytophthora cinnamomi**, CA.

ROT, Wood. **Daldinia concentrica**; **D. vernicosa**; **Hypoxylon atropunctatum**; **Lentinus tigrinus**; **Linzites betulina** and other species; **Schizophyllum commune**; **Steccherinum ochraceum**.

RUST. **Cronartium quercuum** (*C. cerebrum*) II, III, widespread; 0, I on pines; **C. fusiforme** (II, III), southern states; **C. strobilinum** (II), AR, FL, IL, IA, KS, MS, MO; 0, I on long-leaf pines; **C. conigenum** (II, III), AZ; 0, I on pine cones.

RUST, Fusiform. **Cronartium fusiforme**, GA.

SPOT ANTHRACNOSE. **Elsinoë quercus-falcatae**, on southern red oak, GA, NC; **E. quercicola**, FL.

VIRUS. **Oak Ringspot**, AR.

WILT, Dieback. **Fusarium oxysporum** or **F. solani**, VA; also canker; **Phytophthora europa** (also yellowing and dieback), North Central U.S., MN, OH, PA, WV, WI.

WILT, Oak. **Ceratocystis fagacearum** (*Chalara quercina*), AR, FL, IL, IN, IA, KS, KY, MD, MI, MN, MO, NE, NC, OH, OK, PA, SC, TN, VA, WV, WI.

WITCHES' BROOM. **Articularia quercina** var. **minor**. AZ, NM, UT.

Oak wilt is our most serious disease with red and black oaks often dying the first season symptoms appear. Anthracnose is general, most severe on white oak, defoliating in wet seasons. Leaf blister, important in the South, can be prevented by a single dormant spray. Powdery mildew, due to *Sphaerotheca lanestris*, is important in California, where it produces witches' brooms on live oaks. The honey mushroom, *Armillaria mellea*, sometimes called the oak fungus, causes "shoestring" root rot. Strumella canker is frequent in forest trees, sometimes found in ornamentals.

OCOTILLO, COACH-WHIP, CANDLEWOOD (*Fouquieria*)

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Aecidium cannonii** (0, I), AZ.

OENOTHERA (Evening-Primrose)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.

DODDER. **Cuscuta arvensis**, OK.

DOWNY MILDEW. **Peronospora arthuri**, MA to MS, KS, MT, NE, OK, SD.

GALL, Leaf. **Synchytrium fulgens**, AL, KS, LA, MS, NC, OK, TX to CA.

LEAF SPOT. **Alternaria tenuis**, secondary, NJ; **Cercospora oenotherae**, AL, KS, TX, WV; **C. oenotherae-sinutae**, AL, NC; **Pezizella oenotherae**, GA, MD, NC, SD, VA; **Pestalotia oenotherae**, OH, OK; **Septoria oenotherae**, ME to FL, CA, NM, OK, SD, UT.

POWDERY MILDEW. **Erysiphe polygoni**, general.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX; **Sclerotinia minor**, NC.

RUST. **Aecidium anograe** (0, I), NE; **Puccinia aristidae** (0, I), AZ, NV; II, III on grasses; **P. dioicae** (0, I), ME to AL, CA, CO, ND, TX; II, III on *Carex*; **P. oenotherae** (0, I, II, III), CO, CA to MT, WA; **Uromyces plumbarius** (0, I, II, III), general.

VIRUS. **Mosaic**. Unidentified, PA.

OHIA (*Metrosideros* spp.); also *Eugenia, Syzgium* and *Psidium* spp. in Myrtaceae Family

RUST. **Puccinia psidii**, HI.

OKRA (*Hibiscus esculentus*)

ANTHRACNOSE. **Colletotrichum gloeosporioides**, pod spot, FL, PA; **C. hibisci**, dieback, TX.

BLIGHT, Blossoms. **Choanephora cucurbitarum**, FL, GA, TX.

LEAF SPOT. **Ascochyta abelmoschi**, GA, MD, NJ, NY, pod spot; **Alternaria** sp., secondary, FL, OH, PA, SC, UT; **Cercospora abelmoschi** (*C. hibisci*), NC to FL, TX; **C. malayensis**, VA to FL, OK, TX; **Corynespora cassiicola**; **Phyllosticta hibiscina**, AL, IL, NJ, NC, OK.

NEMATODE, Root Knot. **Meloidogyne incognita**, general.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CT, NJ, NC, PA.

ROT, Charcoal. **Macrophomina phaseoli**, TX.

ROT, Pod. **Botrytis** sp., NY.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, damping-off, AL, FL; **Thielaviopsis basicola**, NJ.

ROT, Stem. **Sclerotinia sclerotiorum**, MA.

VIRUS. **Tobacco Ring Spot**, GA, VA; **Yellow Mottle**, Mexico.

WILT. **Fusarium oxysporum** f. sp. **vasinfectum**, CT to FL, AZ, TX; **Verticillium albo-atrum**, widespread.

OLEANDER (*Nerium*)

ANTHRACNOSE, Leaf Spot. **Gloeosporium** sp., MA, MS, NJ, TX.

BACTERIAL Knot. **Pseudomonas syringae** pv. **tonelliana**, AZ, CA, CT.

BACTERIAL, Leaf Scorch. **Xylella fastidiosa**, FL.

BLIGHT, Stem and Leaf. **Pseudomonas syringae**, CA.

CANKER; Witches' Broom. **Sphaeropsis** sp., FL.

DODDER. **Cuscuta indecora**, FL.

LEAF SPOT. **Alternaria** sp. (*Macrosporium nerii*), AL, CA, FL, GA, MS; **Cercospora neriella**, also pod spot, AL, FL, LA, TX; **Phyllosticta nerii**, FL, LA, MI, TX; **Septoria oleandrina**, CA, FL, LA.

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

ROT, Stem. **Calonectria crotalariae**, CA.
SOOTY MOLD. **Capnodium elongatum**, AL, FL.
SPOT ANTHRACNOSE, Scab. **Sphaceloma oleandri**, LA.

OLIVE (*Olea*)

ANTHRACNOSE. **Gloeosporium olivarum**, CA.
BACTERIAL Knot. **Pseudomonas syringae** pv. **savastanoi**, CA.
BLACK MILDEW; Leaf Spot. **Asternia oleina**, FL, GA.
DODDER. **Cuscuta indecora**, CA.
LEAF SPOT. **Cycloclonium oleaginum**, peacock spot, CA; **Cercospora caldosporioides**, also fruit spot, CA.
NEMATODE, Citrus. **Tylenchulus semipenetrans**.
NEMATODE, Lesion. **Pratylenchus musicola** (*P. coffeae*), CA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA.
NONPARISITIC **Bitter Pit** and **Dry Rot** of fruit. Overnutrition
Exanthema. Dieback. Deficiency of organic matter.
Fruit Pit. Boron deficiency.
Soft Nose. Blue Nose. Moisture supply. On variety Sevillano only.
ROT, Root. **Armillaria mellea**, CA, TX; **Phymatotrichum omnivorum**, TX; **Polyporus olaea**, CA.
VIRUS. **Sickle Leaf**.
WILT. **Verticillium albo-atrum**, CA.

ONCOBA

ROT, Root. **Phymatotrichum omnivorum**, TX.

ONION (*Allium cepa*)

BACTERIAL, MLO. **Aster Yellows** and **California Aster Yellows**, widespread.
BACTERIAL Rot; Slippery Skin. **Pseudomonas alliicola**, MA, NY, WA; **P. cepacia**, sour skin, scale rot, NY; **Enterobacter cloacae**, bulb decay, CO.
BACTERIAL Soft Rot. **Erwinia carotovora**, widespread in field, transit, storage.

BACTERIAL, Yellows. **Spiroplasma citri**, CA.

BACTERIAL Leaf Blight. **Xanthomonas campestris**, CA, FL, HI, TX; **X. axonopodis**, GA; **Pantoea ananatis**. CO.

BLIGHT, Southern. **Sclerotium rolfsii**, AL, CA, GA, OK, TX.

BLOTCH, Purple, Brown. **Alternaria porri**, ME to MS, CO, TX, UT; **A. tennis**, CO; **A. tenuissima**, CO.

DAMPING-OFF. **Pythium** spp., ID, MA, NY; **Rhizoctonia solani**, occasional.

DECAY, Bulb; internal. **Enterobacter cloacae**, CA.

DODDER. **Cuscuta** spp., widespread.

DOWNY MILDEW. **Peronospora destructor**, general.

LEAF BLIGHT; Bulb Rot. **Pantoea agglomerans**, GA.

LEAF SPOT. **Heterosporium allii**, CA, CO, WA; **Phyllosticta allii**, IL, NM; **Stemphylium vesicarium**, TX.

NEMATODE, Bulb. Onion Bloat. **Ditylenchus dipsaci**, NY, TX.

NEMATODE, Root Knot. **Meloidogyne incognita**.

NEMATODE, Sting. **Belonolaimus gracilis**.

NEMATODE, Stubby Root. **Paratrichodorus christiei**.

NONPARASITIC. **Blast**, of inflorescence. Appears in Connecticut Valley when bright sun follows cloudy weather. Air pollution in NJ.

Chlorosis. Copper deficiency, FL, NY; Manganese deficiency, NY, RI.

Scald. High temperature, general in summer.

Stain, alkali spot. Contact with alkaline materials or ammonia fumes in transit.

POWDERY MILDEW. **Oidiopsis taurica**, CA; **Leveillula taurica**, ID, Pacific Northwest.

PHYTOPLASMA. **Aster Yellows, Clover Proliferation**, TX.

ROT, Basal. **Fusarium oxysporum** f. sp. **cepae**, other species, widespread.

ROT, Black Stalk, Tip Blight, Seed Mold. **Stemphylium botryosum**, AR, CA, LA, NH, TX, WA.

ROT, Charcoal, **Macrophomina phaseoli**, CA, OK, TX.

ROT, Dry. **Diplodia natalensis**, TX; **Helminthosporium allii**, also canker.

ROT, Neck; Gray Mold. **Botrytis allii**, CA, LA, NJ, TX; **B. cinerea**; Small Sclerotial; Leaf Blight, **B**. (*Botryotinia, Sclerotinia*) **squamosa**, occasional; **B. porri**, WA.

ROT, Pink Root. **Pyrenochaeta terrestris**, widespread.

ROT, Root. **Thielaviopsis basicola**, TX.

ROT, Smudge. **Colletotrichum circinans**, general.

ROT, Soft. **Kluyveromyces marxianus** var. **marxianus**, OR, WA.

ROT, Various, of bulbs. **Aspergillus niger**, black mold, general in market; **Penicillium** spp., blue mold; **Rhizopus stolonifer**, soft, after sunscald or freezing; **Sclerotinia sclerotiorum**, watery soft; **Fusarium proliferatum**, bulb rot, WA.

ROT, White. **Sclerotium cepivorum**, CA, KY, LA, NJ, NY, OH, OR, PA, TX, VA.

RUST. **Puccinia asparagi** (0, I, II, III), CA, CT, IA, KS, MN; **P. allii** (*P. porri*) (II, III), CA, CT, NE.

SMUT. **Urocystis cepulae**, general; **U. colchici**.

VIRUS. **Onion Yellow Dwarf**; Scape Blight caused by **Impatiens Necrotic Spot** and other Tospovirus isolate/strain, ID, including Iris Yellow Spot, CO, GA, ID, NM, OR, TX, WA (also on wild onions, **Allium pskemense**, **A. vavilovii**, and **A. altaicum**).

VIRUS. **Onion Yellow Spot**, Tospovirus, TX.

Smut is the most general onion disease, but it seldom afflicts onions grown from sets, the usual method for a small garden. Growing colored instead of white onions avoids smudge and neck rots to some extent. Sweet Spanish onions are resistant to pink root and yellow dwarf.

ONOSMODIUM (Marbleseed)

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia recondita** (0, I), CO, KS, NE, ND.

OPLISMENUS (Basket-grass)

LEAF SPOT, Tar. **Phyllachora punctum**, FL, LA.

ORANGE

► Citrus Fruits.

ORCHIDS *(Dendrobium)*

BLIGHT, Flower and Leaf; Rot, Root. **Fusarium proliferatum**, **F. solani**, **F. oxysporum**, **F. subglutinans**, HI.

ORCHIDS (Imported Species)

ANTHRACNOSE; Leaf and Stem Spot. **Colletotrichum cinctum** and **C. gloeosporioides** (*Glomerella cincta* and *G. cingulata*), general; **Gloeosporium affine**, FL; **G. cattleyae**, VA.

BACTERIAL Brown Rot. **Erwinia cypripedii**; **Burkholderia gladioli**.

BACTERIAL Brown Spot. **Pseudomonas cattleyae**, common on *Cattleya*, severe on *Phalaenopsis*.

BACTERIAL Leaf Scorch and Pseudobulb Rot. Unidentified.

BACTERIAL Soft Rot. **Erwinia carotovora**, serious on *Cattleya* and other general; **Burkholderia gladioli** (also leaf spot), HI.

BLIGHT, Petal. **Botrytis cinerea** (*Sclerotinia fuckeliana*), spotting common on older flowers; **Glomerella** sp., black spot of *Vanda* orchids.

BLOTCH, Sooty. **Gloeodes pomigena**.

DODDER. **Cuscuta gronovii**; Laurel-Dodder. **Cassytha filiformis**.

LEAF ROT. **Sclerotinia rolfsii**, FL.

LEAF SPOT. **Cercospora epipactidis**; **C. cypripedii**; **C. peristeriae**; **C. dendrobii**; **C. odontoglossi**; **Chaetodiplodia** sp.; **Phyllostictina pyriformis**; **Physalospora** spp., also stem decay; **Diplodia laeliocattleyae**; **Phyllosticta** spp.; **Selenophoma** spp.; **Septoria selenophomoides**; **Volutella albido-pila**.

FLYSPECK. **Microthyriella rubi**.

NEMATODE, Lesion. **Pratylenchus pratensis**; **P. scribneri**.

NONPARASITIC. **Cattleya Dry Sepal**. Industrial fumes.

ROT, Black; Leaf and Heart. **Phytophthora cactorum**; **Pythium ultimum**, serious on *Cattleyas*; **P. splendens**.

ROT, Dry. **Nectria bulbicola**, secondary.

ROT, Root. **Rhizoctonia solani**; Soft, **Fusarium moniliforme**, CA.

ROT, Stem; Southern Blight. **Sclerotium rolfsii**.

RUST. **Uredo behnickiana** (II), FL, NJ, NY; **U. epidendri** (II) FL; **U. guacae** (II), FL; **U. nigropuncta** (II), FL; **Sphenospora kevorkianii**, FL; **S. mera**, FL; **S. saphena**, FL.

SNOW MOLD. **Ptychogaster** sp. Potting fiber mold.

SOOTY MOLD. **Capnodium citri**.

VIRUS. **Cymbidium Mosaic**, CA, HI; **Orchid Fleck**; **Mild Cattleya Color-Break**; **Severe Cattleya Color-Break**; **Cattleya Blossom Brown Necrotic Streak**; **Odontoglossum Ring Spot**, HI; **Oncidium Ring Spot**; **Tomato Spotted Wilt**, HI; **Vanda Ring Spot**; **Spiranthes Mosaic**, MD.

WILT. **Fusarium oxysporum** f. sp. **cattleyae**, CA, FL, OH; **F. moniliforme**.

When dividing plants use a "hot knife" or disinfest between cuts; keep new orchids isolated; sterilize or fumigate the potting medium and disinfest the bench. Destroy plants seriously affected by rusts.

ORCHIDS (Native Species)

LEAF SPOT. **Cercospora cypripedii**, NY, WI; **Fusicladium aplectri**, DE; **Mycosphaerella cypripedii**, NY; **Phyllosticta aplectri**, DE; **Septoria calypsonis**, MI.

RUST. **Puccinia praegracilis** (*Aecidium graebnerianum*) (I), AK, CA, MT, OR, WA; **P. cypripedii** (II, III), IN, IA, MI, NJ, VA, WI; **Uredo goodyerae** (II, III), CA, CO, NM, OR, WA.

OREGANO, SWEET MARJORAM (*Origanum*)

RUST. **Puccinia menthae**, CA, FL.

OSAGE-ORANGE (*Maclura*)

BLIGHT, Leaf. **Sporodesmium maclurae**, MO, SC, TX; **Botrytis cinerea**, OR, gray mold on stems.

DAMPING-OFF. **Pythium ultimum**, NE; **Rhizoctonia solani**, NE.

LEAF SPOT. **Cercospora maclurae**, AL; **Ovularia maclurae**, AL, LA, TX; **Phyllosticta maclurae**, MO, NJ.

MISTLETOE. **Phorodendron tomentosum**, TX; **P. serotinum** (**flavescens**), TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Cerotelium fici** (II), SC to FL and TX.

WILT. **Verticillium** sp., CT.

OSIER, BASKET-WILLOW (*Salix*)

CANKER. **Cryptomyces maximus**, Blister; **Valsa salicina**, Twig, Branch, CA, IA.

RUST, Leaf. **Melampsora abieti-capraearum**, NY, PA.

OSOBERRY (*Osmaronia*)

LEAF SPOT. **Cylindrosporium nuttallii**, CA to OR, WA; **Gloeosporium osmaroniae**, WA.
POWDERY MILDEW. **Phyllactinia corylea**, OR.

OWLS CLOVER (*Orthocarpus*)

LEAF SPOT. **Ascochyta garrettiana**, OR, UT.
RUST. **Cronartium coleosporioides** (II, III), CO, ID, UT; 0, I on pine.

OXALIS (Wood-Sorrel)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Cercospora oxalidiphila**, WI; **Phyllosticta guttulatae**, VT to NJ, IN, WI, **Ramularia oxalidis**, NE, NH, NM, OR, PA, TN, VT; **Septoria acetosella**, NY; tar spot, **Phyllachora oxalina**, DE, ME, VT.
NEMATODE, Root Knot. **Meloidogyne** spp.
NEMATODE, Stem. **Ditylenchus dipsaci**, NY.
POWDERY MILDEW. **Microsphaera russellii**, ME to WV, KS, MN, WA.
ROT, Root. **Thielaviopsis basicola**, CT.
RUST. **Puccinia andropogonis** (0, I), OK, TX, II, III on *Andropogon*; **P. oxalidis** (II, III), FL, GA, LA, MS, NM, SC, TN, TX, WI; 0, I on mahonia; **P. sorghi** (0,I), IN, IA, KS, MI, MS, ND, OK, SD, TX; II, III on corn and *Euchlaena*.
SMUT, Seed. **Ustilago oxalidis**, CT to MS, OH, TX, WI.
VIRUS. **Beet Curly Top**, TX; **Tomato Ringspot**, PA; **Tomato Spotted Wilt**, PA; **Shamrock Chlorotic Ringspot**.

OXYDENDRON (Sourwood, Sorrel-Tree)

BLIGHT, Twig. **Sphaerulina polyspora**, NC.
LEAF SPOT. **Cercospora oxydendri**, AL, MS, TX, WV; **Mycosphaerella caroliniana**, GA, NC, TX, WV.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Poria punctata**, WV.

OYSTER MUSHROOM (*Pleurotus ostreatus*)

DRY BUBBLE. **Verticillium fungicola**, PA.

PACHISTIMA

LEAF SPOT. **Mycosphaerella pachystimae**, ID.

PACHYSANDRA (Japanese-Spurge)

BLIGHT, Leaf; Stem Canker. **Volutella pachysandrae** (*Pseudonectria pachysandricola*), CT, DE, NJ, NY, PA, VA; **Sphaeropsis** sp., tip blight, secondary.

LEAF SPOT. **Gloeosporium** sp., VA; **Phyllosticta pachysandrae**, NY, NC, PA, VA; **Septoria pachysandrae**, FL, TN.

NEMATODE, Root Knot. **Meloidogyne** sp.

VIRUS. **Alfalfa Mosaic**, NJ.

Volutella leaf blight is fairly common after injury or when plants are too crowded; pinkish spore pustules appear on stems, large brown areas on leaves.

PACIFIC WAX MYRTLE (*Myrica californica*)

LEAF SPOT. **Phyllosticta myricae**, CA.

RUST. **Cronartium comptoniae** (II, III), OR.

PAINTED CUP, INDIAN PAINTBRUSH (*Castilleja*)

LEAF SPOT. **Cercospora** sp., AK.

POWDERY MILDEW. **Erysiphe polygoni**, CO, WA; **Sphaerotheca macularis**, CO, WA, WI.

RUST. **Cronartium coleosporioides** (II, III), CA, CO, SD to NM, UT, WA, WY; 0, I on pine; **Puccinia andropogonis** (0, I), CA, IA MT, NM, WI; II, III on *Andropogon*; **P. castillejae** (II, III), CA, UT.

PALM (*Chamaedorea*)

ROT, Stem. **Gliocladium vermoeseni**, FL.
LEAF SPOT. **Bipolaris setariae**, FL; **Exserohilum** (*Helminthosporium*) **rostratum**, FL; **Phaeotrichoconis crotalariae**, FL.

PALM ARECA (*Chrysalidocarpus*)

BLIGHT, Southern. **Sclerotium rolfsii**, CA.
LEAF SPOT. **Bipolaris setariae**, FL; **Exserohilum** (*Helminthosporium*) **rostratum**, FL; **Phaeotrichoconis crotalariae**, FL.

PALM, COCONUT (*Cocos*)

BACTERIAL, MLO. **Lethal Yellowing**, FL.
BLIGHT, Thread. **Pellicularia koleroga**, FL.
LEAF SCORCH; Leaf-Bitten Disease; Stem Bleeding. **Ceratocystis** (*Endoconidiophora, Thielaviopsis*) **paradoxa**, FL.
LEAF SPOT, Gray; Leaf Break. **Pestalotia palmarum**, secondary, FL.
ROT, Bud; Leaf Drop; Wilt. **Phytophthora palmivora**, FL; **Pythium** sp., wilt, FL.

PALM, DATE (*Phoenix*)

BLIGHT, Inflorescence; Fruit Rot. **Fusarium** spp., AZ.
CANKER. **Penicillium vermoeseni**, CA.
FRUIT SPOT, Brown. **Helminthosporium molle**, AZ; **Alternaria citri**, AZ, CA, TX.
LEAF SCORCH; Black Heart; Bud Rot. **Ceratocystis paradoxa**, AZ, CA.
LEAF SPOT. **Exosporium palmivorum**, Gulf states; **Pestalotia** sp., CA, FL; **P. palmarum**, FL; **Alternaria** sp., AZ, CA, FL, TX; **Annellophora phoenicis**, TX.
NEMATODE, Root Knot. **Meloidogyne** spp., AZ, CA.
NONPARASITIC. **Black Nose**. Fruit checking from rain and high humidity. **Chlorosis**. Manganese deficiency, FL.
ROT; Decline Disease. **Omphalia pigmentata** and **O. tralucida**, CA.

ROT, Fruit. **Aspergillus niger**, Calyx-end, CA, WA; **Catenularia fuliginea**, AZ, CA; **Penicillium roseum**, AZ, CA; **Pleospora herbarum**, CA; **Phomopsis phoenicola**, CA; **Alternaria stemphylioides**, CA.
ROT, Leaf-stalk; Shoot Blight; Fruit Rot. **Diplodia phoenicum**, AZ, CA.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Ceratostomella radiciola**, CA.
ROT, Wood. **Poria** spp., AZ, CA.
SMUT, False. **Graphiola phoenicis**, widespread.

PALM, FISHTAIL (*Caryota*)

BLIGHT, Leaf and Stem. **Glomerella cingulata**.
LEAF SPOT. **Bipolaris setariae**, FL; **Exserohilum** (*Helminthosporium*) **rostratum**, FL; **Phaeotrichoconis crotalariae**, FL.

PALM, FORSTER SENTRY (Sentry Palm) KENTIA (*Howeia*)

LEAF SPOT. **Calonectria colhounii**; **C. crotalariae**; **C. theae**, HI.

PALM, PINDO (*Butia*)

ROT, Root. **Armillaria tabescens**, SC.

PALM, QUEEN, PLUMY COCONUT (*Arecastrum*)

CANKER; Gummosis. **Dothiorella gregaria**, CA; **Penicillium vermoeseni**, CA.
LEAF SPOT. **Exosporium palmivorum**, FL; **Glomerella cincta**, NJ; **Septoria cocoina**, MO.
NONPARASITIC. **Chlorosis**. Manganese deficiency, FL.
ROT, Bud; Wilt. **Phytophthora palmivora**, FL; **Pythium** sp., wilt.
ROT, Butt. **Ganoderma sulcatum**, FL.
SMUT, False. **Graphiola phoenicis**, FL.

PALM, Rhapis (*Rhapis*)

LEAF SPOT. **Bipolaris setariae**, FL; **Exserohilum** (*Helminthosporium*) **rostratum**, FL; **Phaeotrichoconis crotalariae**, FL.

PALM, ROYAL (*Roystonea*)

ANTHRACNOSE; Petiole Spot. **Colletotrichum gloeosporioides**, FL, TX.
LEAF SPOT. **Alternaria** sp., FL; **Diplodia** sp., FL; **Epicoccum neglectum**, FL; **Helminthosporium** sp., leaf stripe, FL.
LITTLE LEAF. Cause unknown, FL.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
NEMATODE, Spiral. **Helicotylenchus nannus**.
SMUT, False. **Graphiola phoenicis**, FL.
WILT. **Phytophthora palmivora**, FL.

PALM, SUGAR (*Arenga*)

SMUT, False. **Graphiola phoenicis**, occasional.

PALM, WASHINGTON (*Washingtonia*)

BACTERIAL Leaf Spot. **Pseudomonas washingtoniae**, AZ.
LEAF SPOT. **Auerswaldia** sp., CA; **Cercospora** sp., FL; **Colletotrichum** sp., FL; **Cylindrocladium macrosporium**, FL; **Pestalotia palmarum**, FL; **Phoma palmicola**, secondary, TX.
NEMATODE, Root Knot. **Meloidogyne** spp., AZ, FL.
ROT, Bud. **Penicillium vermoeseni**, CA; **Phytophthora palmivora**, AZ, FL.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, FL.
ROT, Trunk. **Phytophthora** sp., CA.
SMUT, False. **Graphiola phoenicis**, FL, TX.
VIRUS. **Palm Mosaic**, CA.
WILT. **Pythium** sp., FL.
The Penicillium bud rot causes serious losses to *Washingtonia filifera* in California; *W. robusta* is resistant.

PALMETTO, CABBAGE PALM (*Sabal*)

BLACK MILDEW. **Asterina sabalicola**, FL, GA; **Meliola** spp., Gulf states.
CANKER, Felt Fungus. **Septobasidium sabalis**, LA; **S. sabal-minor**, FL.
FRUIT DROP (Premature). **Colletotrichum pleosporioides**, FL.
LEAF SPOT. **Helminthosporium apiculiferum**, LA, MS; **Mycosphaerella serrulata**, FL, SC; **Phyllachora** (*Catacauma*) **sabal**, Black Spot, FL, GA, TX; **Phyllosticta palmetto**, LA, MS; **Myrianginella sabaleos**, Black Speck, FL, GA.
SMUT, False. **Graphiola congesta**, AL, FL, SC; **G. phoenicis**, FL, MS; **G. thaxteri**, FL.

PALOVERDE (*Cercidium*)

MISTLETOE. **Phoradendron californicum**, TX to CA.
ROT, Root. **Phymatotrichum omnivorum**, TX.

PAMPAS GRASS (*Cordaderia*)

LEAF SPOT. **Helminthosporium** sp., GA; **Hendersonia culmiseda**, leaf mold; **Phyllosticta** sp., KY.

PANDANUS (Screw Pine)

LEAF SPOT. **Heterosporium iridis**, IA; **Macrophoma pandani**, CA, FL; **Melanconium pandani**, FL, MD; **Phomopsis** sp., NJ; **Pestalotia palmarum**, secondary, FL; **Volutella mellea**, NY.
NEMATODE, Burrowing. **Radopholus similis**, FL.

PANSY (*Viola tricolor*)

ANTHRACNOSE. **Colletotrichum violae-tricoloris**, ME to FL, IN, MI, PA, WA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, LA, NJ, probably general.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, VA.
DAMPING-OFF; Root Rot. **Pythium** spp., CA, CT, MO, NJ; **Rhizoctonia solani**, DE, IL, MN, NY.

DOWNY MILDEW. **Peronospora violae**, AL, IL, MS, NE.
LEAF SPOT. **Alternaria violae**, NJ, NY, PA; **Cercospora violae**, CT, IN, MI, NY, TX, WI; **Phyllosticta rafinesquii**, AL, IL; **Ramularia agrestis**, OR; **R. lactea**, WA.
NEMATODE, Root Knot. **Meloidogyne** sp., NY, TX.
POWDERY MILDEW. **Sphaerotheca macularis**, IA, KS, WA.
ROT; Crown. **Myrothecium roridum**, AL.
ROT; Leaf Spot. **Centrospora acerina**, CA, GA.
ROT, Root; Wilt. **Aphanomyces cladogamus**, MD; **Fusarium oxysporum**, CT, MI, NE, NJ, NY, OH, TX; **Thielaviopsis basicola** (*Chalara elegans*), CT.
RUST. **Puccinia ellisiana** (0, I), KS, NE; II, III on *Andropogon*; **P. violae** (0, I, II, III), CT, FL, KS, NJ, ND, SC; **Uromyces andropogonis** (0, I), CT; II, III on *Andropogon*.
SMUT, Seed. **Urocystis kmetiana**, AR, MO, TN.
SPOT ANTHRACNOSE; Pansy Scab. **Sphaceloma violae**, KY, MD, NJ.
VIRUS. **Beet Curly Top**, CA, OR, TX; **Mosaic**, unidentified, MD; **Western Cucumber Mosaic** and **Cherry Calico** cause flower break and leaf mottle in CA; **Tomato Spotted Wilt – Lettuce Serotype**, GA.

PAPAYA (*Carica*)

ANTHRACNOSE; Fruit, Stem, and Leaf Spot. **Glomerella cingulata**, general.
BLACK MILDEW. **Asterina caricarum**, FL.
BLIGHT, Flower; Leaf Spot. **Choanephora americana**, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
DAMPING-OFF. **Pythium aphanidermatum**, CA, FL; **P. debaryanum**, TX; **Colletotrichum gloeosporioides**, HI; also seedling blight.
LEAF SPOT. **Asperisporium caricae**, FL; **Mycosphaerella caricae**, target spot, FL; **Phyllosticta caricae-papayae**, target spot, FL.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA; **Oidium caricae**, FL, TX.
NEMATODE. **Meloidogyne** sp., FL, TX.
ROT, Crown, Collar. **Calonectria** sp. (*Cylindrocladium*), HI.
ROT, Fruit. **Diplodia** sp., TX.
ROT, Stem. **Fusarium** sp., CA, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.
VIRUS. **Tobacco Ring Spot**; **Papaya Mosaic**; **Papaya Ringspot**.

PARKINSONIA

LEAF SPOT. **Cylindrosporium parkinsoniae**, TX; **Phyllosticta parkinsoniae**, TX.
MISTLETOE. **Phoradendron californicum**, CA, TX.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, AZ, TX.
SOOTY MOLD. **Capnodium** sp., TX.

PARROTFEATHER (*Myriophyllum*)

ROT, Root and Stem. **Pythium carolinianum**, CA.

PARSLEY (*Petroselinum*)

BACTERIAL, MLO. **Aster Yellows**, CO, NY; **California Aster Yellows**, CA.
BACTERIAL Soft Rot. **Erwinia aroideae**, CA; **E. carotovora**, FL.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Leaf. **Alternaria dauci**, CT; **Septoria petroselini**, CA, CT, NJ, NY.
DAMPING-OFF; Root Rot. **Pythium** sp., NJ; **Rhizoctonia solani**, NJ, NY.
DODDER. **Cuscuta** sp., TX.
LEAF SPOT. **Cercospora petroselini**, NJ; **Stemphylium** sp., NJ.
NEMATODE, Bulb. **Ditylenchus dipsaci**, CA.
NEMATODE, Pin. **Paratylenchus projectus**, MD.
NEMATODE, Root Knot. **Meloidogyne** spp., FL, GA, KS, TX, VA.
POWDERY MILDEW. **Erysiphe heraclei**, CA, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Phytophthora cryptogea**, CA.
ROT, Stem. **Sclerotinia sclerotiorum**, CT, GA, LA, NY, PA, TX, VA.
VIRUS. **Alfalfa Mosaic**, CA; **Strawberry Latent Ringspot**, CA.
VIRUS. **Beet Curly Top**, CA.

PARSNIP (*Pastinaca*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, VA.
BACTERIAL, MLO. **Aster Yellows**, IL, ME, NY, PA, SD, TX, WI, and **California Aster Yellows**, CA, WA.
BACTERIAL Rot. **Pseudomonas pastinacae**, NY; **Erwinia carotovora**, occasional in storage.
BLIGHT, Leaf; Canker. **Itersonilia perplexans**, GA, MA, NY.
DOWNY MILDEW. **Plasmopara nivea**.
LEAF SPOT. **Alternaria** sp., NJ; **Cercospora pastinacae**, MD, NE, NY, TX, WV; **C. pastinacina**, CA, IN, MI, NY; **Cylindrosporium pastinacae**, UT, WI; **Ramularia pastinacae**, IN, MA, NY, ND, OH; **Septoria pastinacae**, TX; **Cercosporella pastinacae**, MA; **Phomopsis dichenii**.
NEMATODE, Root Knot. **Meloidogyne** spp., NJ to KS and southward.
NONPARASITIC. **Heart Rot**. Boron deficiency, NY.
POWDERY MILDEW. **Erysiphe unbelliferarum**.
ROT, Black, Crown. **Centrospora acerina**.
ROT, Black Mold. **Rhizopus** spp., occasional in storage.
ROT, Gray Mold. **Botrytris cinerea**, occasional.
ROT, Root. **Phymatotrichum omnivorum**, AZ, TX; **Rhizoctonia solani**, black scurf, NC, TX; **Phytophthora parasitica**, dry rot, PA; **Phoma** sp.
ROT, Watery Soft. **Sclerotinia sclerotiorum**, CA, IN, LA, MA.
SCAB. **Streptomyces scabies**, WA.
SCAB, Acid. **Streptomyces acidiscabies**, ME.
VIRUS. **Mosaic**, unidentified, OR, UT.

PARTRIDGE-BERRY (*Mitchella*)

BLACK MILDEW. **Meliola mitchellae**, AL, FL, MS, PA.
ROT, Stem. **Sclerotium rolfsii**, MD.

PASSION FLOWER (*Passiflora*)

BLIGHT, Southern. **Sclerotium rolfsii**, FL.
LEAF SPOT. **Colletotrichum gloeosporioides**, FL, also stem spot; **Cercospora biformis**, AR, NC; **C. fuscovirens**, ME to MO, TX; **C. regalis**,

TX; **C. truncatella**, SC, TX; **Gloeosporium fructigenum**, LA; **Phyllosticta** sp., NJ; **Alternaria passiflorae**, FL, brown spot.

NEMATODE, Root Knot. **Meloidogyne** sp.

ROT, Collar. **Sclerotinia** sp., CA.

ROT, Root. **Phymatotrichum omnivorum**, TX.

VIRUS. **Cucumber Mosaic**, CA; **Passiflora Latent**, FL.

PAULOWNIA (Princess-Tree)

LEAF SPOT. **Ascochyta paulowniae**, MD; **Phyllosticta paulowniae**, AL, MD, NY, OK.

POWDERY MILDEW. **Phyllactinia corylea**; **Uncinula clintonii**.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Armillaria mellea**.

ROT, Wood. **Polyporus spraguei**, AL; **P. versicolor**, MD; **P. robiniophilus**.

PAWPAW (*Asimina*)

BLOTCH, Leaf. **Phloeospora asiminae**, IL, KS, MO, OH, WV.

CANKER; DIEBACK. **Nectria cinnabarina**; **Polyporus amplectrens**, FL, GA; **Sphaeropsis asiminae**, MD, WV; **Valsa ambiens**, VA, WV.

LEAF SPOT. **Cercospora asiminae**, widespread; **Phyllosticta asiminae**, widespread; **Mycosphaerella** sp., IN, OH, WV; **Septoria asiminae**, TX.

PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, Southern U.S., LA.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Sapwood. **Poria isabellina**, VA, WV.

PEA (*Pisum*)

ANTHRACNOSE, Leaf and Pod Spot. **Colletotrichum pisi**, CT, GA, IA, ME, MS, TX.

BACTERIAL Blight. **Pseudomonas syringae** pv. **pisi**, general, especially East and South.

BACTERIAL Leaf Spot. **Pseudomonas syringae**, ID.

BACTERIAL Pink Seed. **Erwinia rhapontici**, MT, Alberta, Canada.

BLIGHT, Ashy Stem, Charcoal Rot. **Macrophomina phaseoli**, TX.

BLIGHT, Foot Rot. **Mycosphaerella pinodes**, widespread, usually with **Ascochyta pinodella**.

BLIGHT, Leaf and Stem. **Choanephora conjuncta**, GA.

BLIGHT, Southern. **Sclerotium rolfsii**, FL.

DAMPING-OFF; Root Rot, Pod Rot. **Pythium** spp. and **Rhizoctonia solani**, general.

DODDER. **Cuscuta** sp., MO.

DOWNY MILDEW. **Peronospora viciae** (*P. pisi*), general, especially north central and Pacific Coast states.

LEAF SPOT. **Alternaria** sp., seedling blight, DE, NH; **A. alternata**, blight, WI; **Ascochyta pisi**, general but rare in Northwest; **Cercospora pisi-sativae**, GA; **Fusicladium pisicola**, black leaf, ID, UT; **Pleospora hyalospora**, MS; **Septoria flagellifera**, MN, ND, SD, WI; **S. pisi**, widespread; **Stemphylium polymorphum**, ME.

NEMATODE, Hop Cyst. **Heterodera humuli**, OR.

NEMATODE, Oat Cyst. **Heterodera avenae**, WA.

NEMATODE, Pea Cyst. **Heterodera gottingiana**, WA.

NEMATODE, Root Knot. **Meloidogyne** spp., AZ, CA, FL, NC, SC, TX, UT, WI.

NEMATODE, Sting. **Belonolaimus gracilis**.

NONPARASITIC. **Chlorosis**. Manganese or zinc deficiency, FL, TX, WA.
Intumescence. Pod swellings, CA, NJ, WA.
Seed Spotting. Cause unknown.

POWDERY MILDEW. **Erysiphe polygoni**, general.

ROT, Black Mold. **Rhizopus stolonifer**, cosmopolitan; gray mold, **Botrytis cinerea**, occasional.

ROT, Foot. **Aphanomyces euteiches**, general except in far North.

ROT, Root. **Aphanomyces euteiches**, ID, MN; **Fusarium solani** f. sp. **pisi**, widespread; **Pellicularia filamentosa**, stem canker, general; **Phoma** sp., NJ, WI; **Pyrenochaeta terrestris**, IA; **Phymatotrichum omnivorum**, TX; **Phytophthora** sp., CA, CT; **Thielaviopsis basicola**, AR, CA; **Rhizoctonia oryzae**, WA.

ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, CA, DE, FL, ID, MT, NJ, PA, TX, VA, WA.

RUST. **Uromyces fabae** (0, I, II, III), CA, ID, ME, MA, MN, NE, ND, WA, WY.

SCAB; Black Spot; Leaf Mold. **Cladosporium pisicola**, CA, ME, OR, TX, UT, WA.

VIRUS. **Pea Enation Mosaic**; **Pea Mosaic**; **Pea Mottle**; **Pea Streak**; **Wisconsin Pea Streak**; **Pea Wilt**; **Clover** (red) **Vein Mosaic**; **Tomato Spotted Wilt**; **Bean Leaf Roll**, CA.

VIRUS. Seed-borne; **Pea Stunt**, WI, **Turnip Mosaic Virus**, MN.

WILT. **Fusarium oxysporum** f. sp. **pisi**, NH to SC, CA, CO, ID, IL, MN, NE, MT, OR, WA; and race 2, Near Wilt; **Fusarium oxysporum** f. sp. **medicaginis**, MS.

Resistant varieties are the answer to Fusarium wilt and some virus diseases. Using clean seed, preferably grown in the West, is the best way to avoid bacterial blight. A well-drained, fertile soil, 3- to 5-year rotation, cleaning up or plowing under pea refuse immediately after harvest, all help to produce healthy peas. Some organic soil amendments reduce pea wilt.

PEACH (*Prunus persica*)

ANTHRACNOSE. **Colletotrichum acutatum**, SC.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general.

BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, general.

BACTERIAL Leaf Spot. **Xanthomonas pruni**, eastern, central, southern states.

BACTERIAL, MLO. **Peach X-Disease**, CT, MA, MI, NY, OH, PA.

BACTERIAL Shoot Blight; Canker; Gummosis. **Pseudomonas syringae**, CA, OR.

BLIGHT, Blossom; Green Fruit Rot. **Sclerotinia sclerotiorum**, CA.

BLIGHT, Leaf. **Fabraea maculata**, CA, NJ.

BLIGHT; Shot-Hole Disease; Pustular Spot. **Coryneum carpophilum**, general.

BLIGHT, Twig. **Coniothyrium** sp., TX; **Cyphella marginata**, OR; **Nectria cinnabarina**, AL.

CANKER, Crown. **Phytophthora citrophthora**, CA; **P. cactorum**, stem, AR, CA; **P. syringae**, OR.

CANKER; DIEBACK; Gummosis. **Botryosphaeria dothidea**, AL, FL, GA, LA, TN, TX.

CANKER; DIEBACK; Gummosis. **Botryosphaeria ribis** var. **chromogena**, FL, GA; **Valsa** (*Cytospora*) **cincta** and **V. leucostoma**, widespread East and central states; **Coniothrium fuckelii**, WV; **Ceratocystis fimbriata**, CA.

CANKER; Peach; Constriction Disease. **Fusicoccum amygdali**, East and South. Sometimes reported as **Phoma persicae**.

DAMPING-OFF. **Rhizoctonia solani**, AR, CT.

DIEBACK. **Phomopsis** sp., AL.

LEAF CURL. **Taphrina deformans**, general.

LEAF SPOT. **Phyllosticta circumscissa**, widespread; **P. persicae**, MD, NE, OH; **Mycosphaerella persicae**, frosty mildew, widespread.

LEAF SPOT; Shot-Hole. **Cercospora circumscissa**, general; **C. consobrina**, IL, LA.

NEMATODE, Dagger. **Xiphinema americanum**; **X. pacificum**, GA.

NEMATODE, Lesion. **Pratylenchus penetrans**; **P. vulnus**.

NEMATODE, Ring. **Criconemoides similis**, **C. xenoplax**, NJ.

NEMATODE, Root Knot. **Meloidogyne incognita**; **M. javanica**, on "nematode-resistant" varieties; **M. arenaria**.

NEMATODE, Sting. **Belonolaimus gracilis**.

NONPARASITIC. **Catface**. Insect blemish on fruit, often from plant bugs.
Chlorosis. Iron and magnesium deficiency in alkaline soils, Southwest.
Gummosis. Winter injury, bad drainage.
Internal Bark Necrosis. Manganese toxicity, IL.
Little Leaf. Zinc deficiency, CA.
Stem Pitting. Cause unknown, WV.
Suture Spot. Cause unknown. Decline, PA.

POWDERY MILDEW. **Podosphaera oxyacanthae**, general; **Sphaerotheca pannosa** var. **persicae**, general.

ROT, Brown. **Monilinia fructicola**, general.

ROT, Brown; Blossom and Twig Blight. **Monilinia laxa**, Pacific states.

ROT, Bud and Twig Blight. **Fusarium lateritium**, other spp., CA, GA, KS.

ROT, Fruit. **Botryosphaeria obtusa**, AL, GA; **B. dothidea**, AL, GA, SC; **Aspergillus niger**, black mold, cosmopolitan; **Botrytis cinerea**, gray mold, cosmopolitan; **Cephalothecium roseum**, pink mold, widespread; **Choanephora persicaria**, in market; **Diplodia natalensis**, gumming disease; **D. persicae**, GA; **Fusarium** spp., CA, IL, NY, TX; **Gibberella persicaria**, CA; **Gilbertella persicaria**, SC; **Glomerella cingulata**, occasional, AL, GA; **Rhizopus nigricans**, cosmopolitan; **Phomopsis** sp., NJ.

ROT, Pink Mold. **Trichothecium roseum**, CA.

ROT, Root. **Armillaria mellea**, cosmopolitan; **Clitocybe monadelpha**, AR, FL, MO, OK; **C. parasitica**, OK; **C. tabescens**, FL, GA; **Gan-**

oderma curtisii, NC, VA; **Phymatotrichum omnivorum**, AZ, TX; **Cylindrocladium floridanum**, GA.

ROT, Root and Crown. **Phytophthora megasperma**, NY, OH; **P. cryptogea**, NY, OH; **P. cactorum**, NY, OH.

ROT, Seedling Stem. **Sclerotium rolfsii**, South; wilt, **Cylindrocladium floridanum**; **Penicillium** sp.

ROT, Silver Leaf. **Stereum purpureum**, occasional.

ROT, Sour. **Geotrichum candidum**, CA, SC; **Issatchenkia scutulata**, CA; **Kloeckera apiculata**, CA.

ROT, Wood. **Fomes** spp.; **Lenzites saepiaria**; **Polyporus hirsutus**, **P. lacteus** and **P. versicolor**, cosmopolitan; **Stereum hirsutum**; **Shizophyllum commune**, wound rot.

RUST. **Tranzschelia discolor** (II, III), general; 0, I on anemone, hepatica.

SCAB. **Cladosporium carpophilum**, general.

SOOTY MOLD; Fruit Stain. **Fumago vagans**, cosmopolitan.

VIRUS. **Peach Asteroid Spot**, OK and TX to southern CA, OR, UT, WA; **Peach Calico**, ID, WA; **Peach Dwarf**; **Peach Golden Net**, CO; **Peach Little Peach**, eastern U. S., CT to NC to MI, MO; **Peach Mosaic**, OK, TX to CA, CO, UT; **Peach Mottle**, ID; **Peach Necrotic Leaf Spot**, MI; **Peach Phony Disease**, Southeast to MO, TX; **Peach Red Suture**, IN, MD, MI; **Peach Ring Spot**, CA, WA, **Peach Rosette**, SC to FL, MS, TN, MI to AR, OK; **Peach Rosette Mosaic**, MI, NY; **Peach Stubby Twig**; **Peach Wart**, AZ, CA, ID, OR, WA; **Peach Yellow Bud Mosaic**, CA, **Peach Yellow Leaf Roll** (Western X-Disease, Cherry Buckskin), CA, CO, ID, OR, UT, WA; **Peach Yellows**; **Mule's Ear Disease** (Drake Almond Bud Failure); **Prunus Ring Spot**; **Cherry Yellows**; **Green Ring Mottle**; **Prunus Necrotic Ring Spot**, CA; **Tomato Ring Spot**, CA; **Peach Latent Mosaic Viroid**, WA; **Hop Stunt Viroid**, Ontario, Canada; **Plum Pox**, PA.

VIRUS. **Stem Pitting**.

WILT. **Verticillium albo-atrum**, occasional.

Brown rot is the No. 1 peach enemy, and spray schedules are built around it, although they start with a dormant spray for leaf curl. Get the latest advice and spray schedule from your county agricultural agent. Peach foliage is sensitive to arsenicals; do not allow a spray prepared for shade trees to touch peaches. The commercial propagator must take many precautions to provide stock free from the numerous viruses.

PEANUT (*Arachis*)

BACTERIAL Wilt. **Pseudomonas solanacearum**, AL, FL, NC, VA.

BACTERIAL Phytoplasma. **Aster Yellows**, OK.

BLIGHT, Seedling. **Rhizoctonia** spp., NC to FL, CA, OK, TX.

BLIGHT, Southern; Stem and Nut Rot. **Sclerotium rolfsii**, general.

BLIGHT, Stem. **Diaporthe sojae**, VA, WV; **Sclerotinia minor**, VA; **S. sclerotiorum**, GA; **Botrytis cinerea**, GA.

BLOTCH, Web. **Phoma arachidicola**, VA.

CANKER, STEM. **Fusarium oxysporum**, AL.

DAMPING-OFF. Synergistic interaction of **Pythium myriotylum**, **Fusarium solani**, **Meloidogyne arenaria**, FL.

LEAF SPOT. **Alternaria** sp., FL, MO, NJ, NM, SC; **Ascochyta** sp., AR; **Cercosporidium personatum**, VA; **Phoma** sp., MO, VA; **Phyllosticta** sp., AL, AR, MS; **Pleospora** sp., AR, OK; **Stemphylium** sp., ND; **Leptosphaerulin arachidicola**, GA, TX; **Sclerotinia homoeocarpa**, FL.

LEAF SPOT, Brown, Halo. **Mycosphaerella arachidicola**, general; **M. berkeleyi** (*Cercospora personata*), general.

LEAF AND STEM DISEASE. **Cercospora zebrina** (clover isolate), NC.

NEMATODE. **Panagrolaimus subelongatus**, associated with shoot elongation.

NEMATODE, Leaf. **Aphelenchoides** sp.

NEMATODE, Lesion. **Pratylenchus brachyurus**, AL, FL, GA, SC, VA.

NEMATODE, Reniform. **Rotylenchus reniformis**.

NEMATODE, Ring. **Criconemoides cylindricum**.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. hapla**; **M. javanica**, GA.

NEMATODE, Spiral. **Helicotylenchus nannus**.

NEMATODE, Sting. **Belonolaimus gracilis**; **B. longicaudatus**.

NEMATODE, Stubby Root. **Trichodorus christiei**.

NEMATODE, Stunt. **Tylenchorhynchus claytoni**.

NONPARASITIC. **Blue Stain**. Seedcoat discoloration.

Chlorosis. Excess lime; magnesium, manganese or iron deficiency.

Necrotic Spot. Nutrient deficiency.

Pops. Empty pods. Nutritional deficiency.

Pouts. Stunting and chlorotic spotting from thrips.

ROT, Black Mold, of Pods. **Cladosporium herbarum**, cosmopolitan.

ROT, Blue Mold, of Pods and Nuts. **Penicillium** sp., cosmopolitan.

ROT, Charcoal. **Macrophomina phaseoli**, CO, NC, OK, SC, TX.
ROT, Collar. **Diplodia gossypina**; **Lasiodiplodia theobromae**, NC, VA.
ROT, Crown. **Aspergillus niger**, GA, NM, TX.
ROT, Cylindrocladium Black Rot. **Cylindrocladium crotalariae**, NC, VA; **C. parasiticum**.
ROT, Gray Mold, Leaf. **Botrytis cinerea**, CT, MD, MS, TN, VA.
ROT, Peg, Pod, Root. **Calonectria** (*Cylindrocladium*) **crotalariae**, GA.
ROT, Root. **Curvularia inaequalis**, SC; **Helminthosporium** sp., OK; **Phymatotrichum omnivorum**, AZ, TX; **Pythium** sp., CA, GA, NC; **Thielaviopsis basicola**, NC.
ROT, Root and Pod. **Sclerotinia minor**, **S. sclerotiorum**, NC, VA; **Sclerotium rolfsii**, FL; **Sclerotinia sclerotiorum**, GA.
ROT, Seed. **Rhizopus** spp.; **Trichoderma viride**, SC.
ROT, Stem, Pod. **Fusarium** spp., also root rot, wilt; **Physalospora rhodina**, FL, GA; **Rhizoctonia solani**; **Sclerotium rolfsii**, FL; **Sclerotinia sclerotiorum**, GA.
RUST. **Puccinia arachidis** (II), occasional, FL, GA, NC, TX, VA.
VIRUS. **Peanut Stunt**, AL, GA, NC, VA; **Peanut Mottle**, OK; **Cowpea Chlorotic Mottle**, SD.
VIRUS. **Impatiens Necrotic Spot**, GA, TX; **Peanut Top Paralysis**, OK; **Tomato Spotted Wilt**, AL, GA, VA, TX; **Peanut Stunt**, FL. GA..
WILT. **Pythium myriotylum**, VA.
WILT. **Verticillium** sp., NM.

PEAR (*Pyrus*)

ANTHRACNOSE, Northwestern. **Neofabraea malicorticis**, OR, WA.
BACTERIAL Blossom, Twig Blight; Canker. **Pseudomonas syringae**, AR, CA, CT.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general.
BACTERIAL Fire Blight. **Erwinia amylovora**, general.
BACTERIAL Fruit Rot. **Erwinia carotovora**, MA.
BLIGHT, Leaf; Black Fruit Spot. **Fabraea maculata**, general.
BLIGHT, Thread. **Pellicularia koleroga**, NC to FL, TX, WV.
BLIGHT, Twig. **Corticium salmonicolor**, FL, LA; **Fusarium** spp., occasional; **Phomopsis ambigua**, widespread; **Valsa leucostoma**, WA.
BLOTCH, Sooty. **Gloeodes pomigena**, eastern states to OK, TX.

CANKER. **Botryosphaeria dothidea**, AL; **Cytospora** spp., OR, VA, WA; **Nectria cinnabarina**, coral spot; dieback; **N. galligena**, trunk canker; **Nummularia discreta**, DE, IA.

CANKER, Bark. **Glutinium microsporum**, OR; **Helminthosporium papulosum**, blister canker, black pox; **Myxosporium corticola**, NY to MI, MS, OR.

CANKER, Felt Fungus. **Septobasidium** spp., NC to FL, TX.

CANKER, Perennial. **Neofabraea perennans**, OR, WA.

FRUIT SPOT; Flyspeck. **Leptothyrium pomi**, eastern states.

LEAF SPOT. **Cercospora minima**, FL to TX; **C. pyri**, MI; **Coniothyrium pyrinum**, MA to AL, IA, TX; **Coryneum foliicola**, IN; **Hendersonia cydoniae**, NY; **Phyllosticta pyrorum**, IL, MS, SC; **Mycosphaerella sentina**, ashy leaf spot, fruit spot, widespread, especially in East.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, TX.

MISTLETOE, European. **Viscum album**, CA.

NEMATODE, Lesion. **Pratylenchus minyus**; **P. pratensis**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp., CA.

NONPARASITIC. **Bitter Pit**. Moisture irregularity, Pacific Coast, NY.

Black End; **Hard End**. Oriental pear rootstocks on shallow, poor soil.

Black Leaf; **Brown Bark Spot**; **Brown Blotch**, of Kieffer fruit. Undetermined.

Chlorosis. Mineral deficiency, soil alkalinity, Pacific Coast.

Cork; Drought Spot; Fruit Pitting. Boron deficiency, Pacific Coast, TX.

Exanthema. Copper deficiency, CA, FL.

Little Leaf; Rosette. Zinc deficiency, sometimes boron, CA.

Marginal Leaf Blight; Scorch. Potassium or calcium deficiency, ID, WA.

Red Leaf. In Oriental pear, undetermined cause.

Scald. Immaturity; deficient ventilation.

Stigmonose. Insect punctures during growth, widespread.

Target Canker, Measles. Undetermined, CA, GA, NY, VA, WA.

POWDERY MILDEW. **Podosphaera leucotricha**, CO, OR, WA; **P. oxyacanthae**, NJ.

ROT, Bitter; Twig, Branch Canker. **Glomerella cingulata**, widespread but not destructive.

ROT, Black; Canker; Leaf Spot. **Physalospora obtusa**, widespread.

ROT, Brown. **Monilinia fructicola**, eastern states, TX, WA.

ROT, Brown; Blossom Blight. **Monilinia laxa**. Pacific states.

ROT; Blossom and Twig Blight. **Botrytis cinerea**, widespread.

ROT, Collar, Root. **Phytophthora cactorum**, widespread; **P. citrophthora**, CA.

ROT, Fruit. **Alternaria** sp., black mold; **Aspergillus** sp., cosmopolitan; **Botryosphaeria ribis**, black rot, VA; **Cephalosporium carpogenum**, storage; **Trichothecium roseum**, occasional pink mold; **Cladosporium** sp., occasional; **Coprinus urticicola**, OR; **Gloeosporium** sp., widespread **Neurospora sitophila**, ripe rot, NC; **Penicillium** spp., blue mold, widespread; **Phialophora malorum**, storage; **Phoma exigua**; **P. mali**; **Rhizopus nigricans**, black mold, cosmopolitan; **Pleospora fructicola**; **Sclerotinia sclerotiorum**, CA, WA; **Sporotrichum malorum**, storage rot, OR, WA; **Phacidiopycnis washingtonensis** (also Canker and Blight), WA; **Sphaeropsis pyriputrescens**, WA.

ROT, Heart. **Fomes igniarius**; **F. pinicola**; **Polyporus** spp.

ROT, Root. **Armillaria mellea**, widespread; **Phymatotrichum omnivorum**, AZ, OK, TX; **Xylaria** sp., ID, IN; **Xylaria mali**, VA; **Phytophthora cinnamomi**.

ROT, Silver Leaf. **Stereum purpureum**, NY, OR; **S. hirsutum**, trunk rot.

ROT, Stem, Calyx. **Phacidiopycnis piri** (also canker and postharvst fruit rot), OR.

ROT, Trunk. **Schizophyllum commune**, cosmopolitan.

RUST, **Gymnosporangium clavariiforme** (0, I), leaves and fruit, SC: **G. clavipes** (0, I), chiefly on fruit; **G. fuseum**, CA; **G. globosum** (0, I), on leaves and fruit, eastern states to IA, MN; **G. hyalinum** (0, I), FL; **G. kernianum** (0, I), on leaves and fruit, AZ, CO; **G. nootkatense** (0, I), on Asiatic pear, AK.

SCAB. **Venturia pyrina**, general.

SPOT ANTHRACNOSE, Scab. **Elsinoë pini**, OR, WA.

VIRUS. **Apple Chlorotic Leaf Spot**, **Spy Epinasty Decline**, **Virginia Crab Stem Pitting and Brownline**, **Apple Mosaic**, **Flat Limb**, **Pear Vein Yellows/Red Mottle**, **Pear Ring-Pattern Mosaic**, **Pear Latent** on Bradford Pear (*Pyrus calleryana*), MD.

VIRUS. **Pear Stony Pit**, Pacific Coast states, NY; **Pear Decline**, CA, OR, WA; **Pear Leaf Curl**, CA.

VIRUS. **Pear Bark Measles**, CO.

Fire blight is the limiting factor in pear production, many orchards having been abandoned because of this devastating bacterial disease. Kieffer pears and some Asiatic varieties are resistant and are being used in breeding;

some resistant forms are now available. Sprays during blossoming, usually an antibiotic, sometimes combined with weak copper, are used in conjunction with sanitary measures for fire-blight control. Pear decline, a virus disease transmitted by the pear psylla, is serious on the Pacific Coast.

PEA-TREE (*Caragana*)

BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, KY to NE, OK.
BLIGHT, Leaf. **Ascochyta** sp., OH; **Septoria** sp., MN.
BLIGHT, Pod. **Botrytis cinerea**, MA.
DAMPING-OFF. **Rhizoctonia solani**, ND.
LEAF SPOT. **Phyllosticta gallarum**, AK, WI.
POWDERY MILDEW. **Microspora (Erysiphe) palczewskii**, AK, ID, MN, ND, WA.
ROT, Root. **Pellicularia filamentosa**, ND; **Phymatotrichum omnivorum**, TX; **Phytophthora cactorum**, wilt, of seedlings.

PECAN (*Carya illinoensis*)

ANTHRACNOSE. **Glomerella cingulata**, GA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, widespread.
BLIGHT, Thread. **Pellicularia koleroga**, FL, NC.
BLOTCH, Leaf. **Mycosphaerella dendroides**, South.
CANKER. **Cytospora** sp., AZ.
CANKER; Black Bark Spot. **Myriangium tuberculans**, GA, MS.
CANKER; DIEBACK. **Botryosphaeria berengeriana**, AZ, SC, to FL.
CANKER, Stem. **Microcera** (*Fusarium*) **coccophila**, LA, TX.
LEAF SCORCH, FUNGAL. **Xylella fastidiosa**, **Pestalotia**, **Epicoccum**, **Curvularia**, **Fusarium**, LA.
LEAF SPOT. **Microstroma juglandis**, GA to TX; **Phyllosticta convexula**, OK; **Septoria caryae**, TX; **Pestalotia uvicola**, FL, TX.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL.
LEAF SPOT, Brown. **Cercospora fusca**, prevalent through pecan belt.
LEAF SPOT; Downy Spot. **Mycosphaerella caryigena**, GA and FL to TX.
LEAF SPOT; Liver Spot. **Gnomonia caryae** var. **pecanae**, AL, AR, GA, LA, MS, TX.
LEAF SPOT; Vein Spot. **Gnomonia nerviseda**, AR, IL, LA, MS, TX.

LEAF SPOT; Zonate. **Cristulariella pyramidalis**, AL.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), widespread Gulf states.
NEMATODE. **Paratylenchus** sp.; **Trichodorus** sp.
NEMATODE, Awl. **Dolichodorus obtusus**.
NEMATODE, Dagger. **Xiphinema americanum**, Southeast.
NEMATODE, Root Knot. **Meloidogyne** spp.; **M. incognita**; **M. partityla**, FL, GA.
NONPARASITIC. **Black Pit**; **Kernel Spot**. Feeding punctures of plant bugs.
Leaf Scorch. Low fertility and soil moisture capacity.
Rosette. Zinc deficiency.
Sand Burn of Seedlings. High temperature.
POWDERY MILDEW. **Microsphaera alni**, occasional.
ROT, Heart. **Schizophyllum commune**, after drought injury, OK.
ROT, Kernel and Shuck. **Phytophthora cactorum**, GA.
ROT, on nuts. **Aspergillus chevalieri**, storage mold; **Trichothecium roseum**, pink mold.
ROT, Root. **Armillaria mellea**, CA; **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX; **Pestalotia uvicola**, FL, TX; **Clitocybe tabescens**, GA.
SCAB. **Cladosporium effusum**, general.
SPOT ANTHRACNOSE; Nursery Blight. **Elsinoë randii**, southeastern and Gulf states.
VIRUS. **Bunch Disease**. Undetermined.

Pecan scab is the limiting factor in nut production in southeastern states, with strains of the fungus sometimes attacking varieties long considered immune; four or five sprays are required for control. In Arizona severe infection from Phymatotrichum root rot has come where trees are intercropped with lucerne, which provides a rapid transit medium for the fungus. Getting rid of the lucerne and treating with ammonium sulfate saves some trees. Zinc sulfate, added to the soil or to foliar sprays, controls rosette.

PENNISETUM

BACTERIAL STRIPE. **Acidovorax avenae** subsp. **avenae**, GA.
BLACK CHOKE DISEASE. **Ephelis** sp., MD.
LEAF SPOT, Gray. **Pyricularia grisea**, CA.

LEAF SPOT. **Helminthosporium giganteum**, MD; **Phyllosticta penicillariae**, GA; also stunt and chlorosis; **Gaeumannomyces graminis** var. **graminis** (also yellowing), CA.
SMUT, Seed. **Ustilago penniseti**, VA.
VIRUS. **Maize Chlorotic Dwarf Virus**, OH.

PENSTEMON (Beard-Tongue)

BLACK MILDEW. **Dimerium alpinum**, CA.
LEAF SPOT. **Cercospora penstemonis**, AL, IN, KS, MT, NE, ND, OK, SD, TX, WI; **Cercosporella nivosa**, CO, ID, OH, WA; **Phyllosticta antirrhini**, IL; **Ramularia penstemonis**, CA; **Septoria penstemonis**, CA, IL, ME, MI, MS, MO, NY, OK, TX, WA, WI.
LEAF SPOT; Stem Spot. **Ascochyta penstemonis**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp.
NEMATODE, Stem. **Ditylenchus dipsaci**, VA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, WA.
ROT, Crown, Stem. **Sclerotium rolfsii**, CT, IL, MA, NJ, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Root, Crown. **Phytophthora citrophthora**, CA.
RUST. **Puccinia andropogonis** (0, I), widespread; II, III on *Andropogon*; **P. confraga** (III), AZ; **P. palmeri** (0, I, III), AZ, CA, ID, WA, MT, to NM; **P. penstemonis** (III), AZ, CA, OR, UT.

PEONY (*Paeonia*)

ANTHRACNOSE. **Gloeosporium** sp., IL, KS, MD, MA, NJ, NC, PA, VA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD, MI.
BLIGHT, Early Bud Rot. **Botrytis paeoniae**, general.
BLIGHT, Late; Gray Mold. **Botrytis cinerea**, also leaf rot, general.
BLIGHT, Southern. **Sclerotium rolfsii**, MS, TX.
BLIGHT, Tip; Crown Rot. **Phytophthora cactorum**, CT, IL, IN, KS, NJ, NY, OH.
BLOTCH, Leaf, Stem; Measles. **Cladosporium paeoniae**, general.
CANKER, Stem Wilt. **Coniothyrium** sp., CA on tree peonies.
LEAF SPOT. **Alternaria** sp., occasional in northeastern and central states; **Cercospora paeoniae**, IL; **Pezizella oenotherae**, MD, PA; **Phyllosticta**

sp., NJ, PA, VA, **Septoria paeoniae**, also stem canker, ME, MI, MN, NJ, NY, OR, RI, WA, WI; **Cryptostictis paeoniae**, IL.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, NJ, WA.

NEMATODE, Root Knot. **Meloidogyne** spp., widespread; **M. hapla**; **M. incognita**.

NEMATODE, Spiral. **Rotylenchus buxophilus**.

NONPARASITIC. **Bud Blast**. Various causes, sometimes potassium deficiency.

Le Moine Disease; Club Root. Cause unknown, possibly virus.

POWDERY MILDEW. **Erysiphe polygoni**, TX.

ROT, Root. **Armillaria mellea**, CA, IA, MI, OR; **Fusarium** sp., CO, IN, MO, NE, NJ, OK; **Phymatotrichum omnivorum**, AZ, TX; **Rhizoctonia solani**, CT, IL, MN, NY, PA, VA; **Thielaviopsis basicola**, CT.

ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, IL, MD, MN, NJ, NY, OH, OK.

VIRUS. **Peony Ring Spot**, MA to VA, CA, KS, MI, WA.

VIRUS. **Witches' Broom**, **Crown Elongation**. Cause unknown, MD, NY, VA.

WILT. **Verticillium albo-atrum**, IL, KS, MD, NY, OH.

Botrytis blight is doubtless the best-known peony disease. Young shoots are rotted at base; buds turn black, flowers are blasted. Cutting down all tops at ground level in fall and spraying in spring when reddish shoots first show will reduce blight. Anthracnose, blotch, sometimes leaf spot, may be serious occasionally. In humid summers *Sclerotinia sclerotiorum* frequently kills stalks, filling the pith with very large sclerotia. Sickly plants may have root-knot nematodes. Lack of bloom may be due to too-deep planting, growing in shade, Botrytis blight, or nematodes.

PEPEROMIA

ANTHRACNOSE. **Colletotrichum** sp., WA; **Gloeosporium** sp., WA.

LEAF SPOT. **Myrothecium roridum**, FL.

NEMATODE. **Aphelenchoides ritzemabosi**; **Pratylenchus** sp.; **Radopholus similis**, FL.

ROT, Cutting; Root. **Rhizoctonia** sp.; **Pythium splendens**, CA; **Phytophthora palmivora**, CA; **P. nicotianae** var. **parasitica**, OH.

VIRUS. **Cucumber Mosaic**, SC; **Ring Spot**; **Oedema**, pimples in leaves, graft-transmissible, probably due to a virus; **Tobravirus**, IL, MI, MN.

The virus ring spot distorts leaves, which have chlorotic or brown necrotic rings; plants are stunted.

PEPPER (*Capsicum*)

ANTHRACNOSE; Fruit, Leaf and Stem Spot. **Gloeosporium piperatum**, MA to FL, IL, TX; **Glomerella cingulata**, fruit rot, CT to FL, KS, OH, TX; **Colletotrichum capsici**, ripe rot, MS.

BACTERIAL Canker, Vascular. **Clavibacter michiganense**, IN, OH, WY, on *C. annuum* var. *cerasiforme*, and on *C. frutescens* (Bell Pepper), CA.

BACTERIAL Fruit and Stem Spot; Seedling Blight. **Xanthomonas vesicatoria**, general in South and East.

BACTERIAL Leaf Spot. **Xanthomonas vesicatoria**, NC, OH; **X. vitians**, OH; **Pseudomonas syringae**; **P. viridiflava**, FL.

BACTERIAL Soft Rot. **Erwinia aroideae**, and **E. carotovora** pv. **carotovora**, CA, FL, NJ; **Pseudomonas marginalis**, CA, FL, NJ, occasional in market.

BACTERIAL Wilt. **Pseudomonas solanacearum**, PA to FL.

BLIGHT; Blossom Rot. **Choanephora cucurbitarum**, FL, NC.

BLIGHT; Fruit Rot. **Phytophthora capsici**, CA, CO, FL, LA, MO, NM, NY, OH, TX, VA; **P. parasitica**, IL, IN.

BLIGHT, Southern. **Sclerotium rolfsii**, NC to FL.

DAMPING-OFF; Stem and Root Rot. **Pythium** spp., cosmopolitan; **Rhizoctonia solani**, cosmopolitan.

DODDER. **Cuscuta** sp., GA, NJ, VA.

DOWNY MILDEW. **Peronospora tabacina**, GA, NC, SC, TX.

FRUIT SPOT, Black. Nonparasitic, TX.

GIRDLING, Stem. **Nectria haematococca**, FL.

LEAF SPOT. **Ascochyta capsici**, WA, NY to FL; **Cercospora capsici**, frog-eye; stem-end rot; **C. unamunoi**, CA and Gulf states; **Stemphylium solani**, FL; **S. botryosum** f. sp. **capsicum**, NY.

MOLD, Leaf. **Cladosporium herbarum**, CA, GA, TX; Seed Mold, **Stemphylium botryosum**, CT, FL.

NECROSIS, Vascular. **Verticillium dahliae**, NM.

NEMATODE, Awl. **Dolichodorus heterocephalus**.

NEMATODE, Burrowing. **Radopholus similis**.

NEMATODE, Lesion. **Pratylenchus penetrans**.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. incognita**; **M. hapla**.

NEMATODE, Spiral. **Helicotylenchus erythrinae**.

NEMATODE, Stylet. **Tylenchorhynchus claytoni**; **T. capitatus**.

NEMATODE, Tobacco Cyst. **Heterodera tabacum**, VA.

NONPARASITIC. **Blossom-End Rot**. Deficient water supply, also lack of calcium.

Sunscald. High temperature, often after defoliation.

POWDERY MILDEW. **Leveillula taurica**, AZ, CA, FL, HI, NV, NY, OK, UT, British Columbia, Canada.

ROT, Black; Internal Mold, Early Blight. **Alternaria** spp., general after sunscald and blossom-end rot.

ROT, Charcoal. **Macrophomina phaseoli**, CA, GA, KS, NJ, TX.

ROT, Crown. **Sclerotinia minor**, CA.

ROT, Fruit. **Colletotrichum capsici** and **C. nigrum**, general; **Colletotrichum gloeosporioides** and **C. coccodes**, FL; **Diaporthe phaseolorum**, MS, MO; **Phoma destructiva**, AL, DE, FL, GA, MS, NY; **Penicillium** sp., GA; **Rhizopus stolonifer**, FL, TX, WA; **Sclerotinia sclerotiorum**, also stem rot, CA, CT, FL, MA, OH; **Fusarium** spp.; **F. solani**, **Nectria haematococca**, also stem canker; **F. subglutinans**, British Columbia, Canada.

ROT, Gray Mold. **Botrytis cinerea**, occasional in market or field.

ROT, Pod. **Curvularia lunata**, FL; **Nematospora coryli**, yeast spot after plant bug injury.

ROT, Root. **Aphanomyces** sp., NJ, of seedlings; **Phymatotrichum omnivorum**, AZ, TX; **Pythium aphanidermatum**, FL; **P. myriotylum**, FL; **P. helicoides**, FL; **P. splendens**, FL; **P. arrhenomanes**, FL; **P. catenulatum**, FL; **P. irregulare**, FL; **P. graminicola**, FL.

VIRUS. **Pepper Mottle**, CA; **Pepper Strain of Alfalfa Mosaic**; **Pepper Vein-Banding Mosaic** (Potato Y virus); **Potato Virus X**; **Cucumber Mosaic**, FL; **Tobacco Mosaic**; **Tobacco Mosaic** (Jalapeno Pepper), NY; **Tobacco Etch**; **Aster Ring Spot**; **Beet Curly Top**; **Tomato Spotted Wilt**, FL, IN, LA, OH, TN; **Beet Curly Top**, OR; **Pepper Mild Mottle**, FL, OR, SC; **Pepper Mild Tigre**, TX; **Pepper Texas**, TX; **Serrano Golden Mosaic**, AZ; **Tomato Leaf Curl**, CA, Mexico.

VIRUS. **Potato Virus Y** and **Tobacco Ring Spot**, TX; **Impatiens Necrotic Spot**, WA.

WILT. **Fusarium annuum**, AZ, CO, LA, ME, MS, NJ, NM, OK, TX; **Verticillium albo-atrum**, CA, CO, CT, LA, NY, TX.

To control bacterial spot and anthracnose rotate crops, avoiding land growing potatoes, tomatoes, or eggplant the previous year, and do not grow next to other solanaceous crops. To avoid sunscald, keep fruits shaded; spray to control leaf spots to prevent defoliation. For virus diseases, obtain healthy seed or use resistant varieties. Do not start plants in greenhouses with petunias or Jerusalem cherries; do not smoke or handle tobacco near plants; control aphid vectors; control weed hosts before the crop is planted.

PEPPER-GRASS, GARDEN CRESS (*Lepidium*)

DAMPING-OFF. **Pythium debaryanum**, TX; **Rhizoctonia solani**, TX.
DOWNY MILDEW. **Peronospora lepidii**, IA, SD, TX.
ROT, Root. **Pyrenochaeta terrestris**, pink root, ND, SD; **Phymatotrichum omnivorum**, TX.
ROT, Crown. **Sclerotinia sclerotiorum**, MA.
RUST. **Puccinia aristidae** (0, I), TX; II, III on grasses.
VIRUS. **Bidens Mottle**, FL.
WHITE RUST; White Blister. **Albugo candida**, general.

PEPPER VINE, CISSUS (*Ampelopsis arborea*)

BLIGHT, Thread. **Pellicularia koleroga**, LA.
DODDER. **Cuscuta compacta**, FL.
LEAF SPOT. **Cercospora arboreae**, TX; **C. vitis**, LA; **Guignardia bidwellii** f. sp. **parthenocissi**, MS, NJ.

PERIWINKLE, MADAGASCAR (*Catharanthus*)

BLIGHT, Web. **Rhizoctonia solani**, LA; **Sclerotium rolfsii**, LA.
PHYTOPLASMA, Yellowing and Witches' Broom. **Candidatus brasiliense**, Brazil.

PERSIMMON (*Diospyros*)

ANTHRACNOSE; Fruit, Twig, Blight. **Gloeosporium diospyri**, East and South to KS.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA.
BACTERIAL, Witches' Broom. **mLO**, TX.

BLIGHT, Thread. **Pellicularia koleroga**, FL, on Japanese persimmon.

BLIGHT, Twig. **Phoma diospyri**, FL, SC; **Physalospora obtusa**, Gulf states.

BLOTCH, Leaf. **Mycosphaerella diospyri**, Gulf states.

CANKER; DIEBACK. **Diplodia natalensis**, AL, TX; **Botryosphaeria ribis**, AL, LA, MD.

FRUIT SPOT; Fly Speck. **Leptothyrium pomi**, FL; **Macrophoma diospyri**, AL, NJ, TX.

LEAF SPOT, Algal. **Cephaleuros virescens**, FL.

LEAF SPOT, Brown. **Cercospora diospyri**, IL, ME, MS, SC, TX, VA; Black, **C. fuliginosa**, AL, FL, GA, IL, MS, TX; **Pestalotia** sp., secondary; **Phyllosticta** sp., FL, IN; **Ramularia** sp., FL; **Fusicladium levieri**, CT, FL, MS.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL, TX.

MISTLETOE. **Viscum album**, CA, on *Diospyros kakai* (Japanese Persimmon).

NEMATODE, Citrus. **Tylenchulus semipenetrans**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp., FL, SC, TX.

POWDERY MILDEW. **Podosphaera oxyacanthae**, TX.

ROT, Fruit. **Alternaria** sp., occasional on Japanese persimmon; **Botrytis cinerea**, gray mold; **Penicillium expansum**, blue mold, cosmopolitan; **Physalospora** spp., AL, AZ, GA, NY, TX; **Rhizopus stolonifer**, TX.

ROT, Root. **Armillaria mellea**, CA; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Daedalea ambigua**, LA, MS; **Daldinia concentrica**, LA, VA; **Fomes** spp.; **Hericium erinaceus**, LA; **Lentinus tigrinus**, LA, MS; **Pleurotus ostreatus**, LA, MS; **Polyporus** spp.; **Schizophyllum commune**, KY, TN.

WILT. **Cephalosporium diospyri**, AL, AR, FL, GA, MS, NC, OK, SC, TN, TX; **Verticillium albo-atrum**, TX.

Persimmon wilt started in Tennessee in 1933, and at the end of 5 years only 5% of the persimmons in that native stand were alive. Oriental persimmons are resistant.

PETALOSTEMON (Prairie-Clover)

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia andropogonis** (0, I), ND to KS, CO. TX, WY; **Uropyxis petalostemonis** (0, I, II, III), WI to ND, CO, NM.

PETASITES (Butter-Bur)

GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Ramularia variegata**, WI; **Stagonospora petasitidis**, WI.
RUST. **Puccinia conglomerata**, MI, MN, NY, WI; **P. poarum**, AK.

PETUNIA

BACTERIAL Fasciation. **Clavibacter fascians**, CA, OH, PA.
BACTERIAL, MLO. **Aster Yellows**.
BACTERIAL Wilt. **Pseudomonas solanacearum**, FL.
BLIGHT, of old flowers. **Choanephora conjuncta**, GA; **C. cucurbitarum** (whole plant), LA; **Phytophthora infestans**, CA, MD, NY; **Sclerotinia sclerotiorum**, LA.
BLOTCH, Leaf. **Cercospora petuniae**, FL, OK.
DAMPING-OFF. **Rhizoctonia solani**, FL, NJ, NY, NC, OK, PA, TX.
DODDER. **Cuscuta** spp., MD, NJ, NY, OK, TX, WV.
LEAF SPOT. **Ascochyta petuniae**, TX.
NONPARASITIC. **Air Pollution Injury**.
NEMATODE, Root Knot. **Meloidogyne** spp., general in South, occasional in greenhouses.
POWDERY MILDEW. **Oidium** sp., MN, NY, VA.
ROT, Black Stem. **Stemphylium botryosum**, secondary, TX.
ROT, Crown. **Phytophthora nicotianae** var. **parasitica**, FL.
ROT, Crown. **Phytophthora parasitica**, CO.
RUST. **Puccinia aristidae** (0, I), AZ.
VIRUS. **Beet Curly Top**, CA, OR; **Tobacco Etch**; **Tobacco Mosaic**; **Cucumber Mosaic**, general; **Tobacco Ring Spot**; **Tomato Spotted Wilt**, CA; **Impatiens Serotype**, GA, FL; **Petunia Vein-Clearing**, MN; **Potato Rugose Mosaic**; **Bidens Mottle**, FL; **Bromegrass Mosaic**, General; **Calibrachoa Mottle**, CA, FL.
WILT. **Fusarium** sp., WA; **Sclerotinia sclerotiorum**, WA; **Verticillium albo-atrum**, CA.

Dodder is common on petunias, reported in window boxes as well as in garden beds. Plants started in greenhouses may get infected with tobacco mosaic. Smoking around petunias, or a tobacco-stem mulch, may also foster mosaic.

PHILIBERTIA

POWDERY MILDEW. **Phyllactinia corylea**, FL.
RUST. **Puccinia bartholomaei** (0, I), AZ; **P. obliqua** (III), AZ, CA, FL, NM, TX.

PHILODENDRON

ANTHRACNOSE. **Gloeosporium** sp., WA; **Colletotrichum** sp., WA.
BACTERIAL Leaf Rot. **Erwinia chrysanthemi**, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, CA.
LEAF SPOT. **Colletotrichum philodendri**, NJ.
NEMATODE, Burrowing. **Radopholus similis**, FL; Root Knot. **Meloidogyne** sp.
NEMATODE, Spiral. **Helicotylenchus nannus**: Lesion **Pratylenchus** sp., FL.
NONPARASITIC. **Exudation** of sugars, CA.
ROT, Root. **Pythium splendens**, FL.
ROT, Stem. **Phytophthora** spp., FL.
SOOTY MOLD. **Capnodium** sp.

PHLOX

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, NJ.
BACTERIAL Fasciation. **Clavibacter fascians**, CA.
BACTERIAL, MLO. **Aster Yellows**, NJ, NY, PA, and **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
BLIGHT, Stem. **Pyrenochaeta phlogis**, NY.
BLIGHT, Southern; Crown Rot. **Sclerotium rolfsii**, CT, FL, IL, MD, NJ, NY, OH, TX, VA.
CANKER, Stem. **Colletotrichum** sp., FL.
DOWNY MILDEW. **Peronospora phlogina**, IA, WI.
LEAF SPOT. **Ascochyta phlogis** var. **phlogina**, MA, NY, TX; **Cercospora omphakodes**, NY to IA, WI; **Macrophoma cylindrospora**, CA; **Phyllosticta** sp., WA; **Septoria** spp.; **Volutella phlogina**, LA; **Ramularia** sp., WA; **Stemphylium botryosum** (*Pleospora herbarum*), NJ.
NEMATODE, Leaf. **Aphelenchoides fragariae**, MD.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CA, CT, MD, NJ, NY, OH, TX, WA.

NEMATODE, Root Knot. **Meloidogyne** spp., KS, MD, MA, NJ, OH, TX, WA.

NONPARASITIC. **Leaf Drop**; "Rust," Blight. Cause uncertain but includes inability of old stems of some varieties to take up enough water.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Sphaerotheca macularis**, KS, NH, NY, OH, WA.

ROT, Charcoal. **Macrophomina phaseoli**, IL.

ROT, Root. **Thielaviopsis basicola**; **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia douglasii** (0, I, III), CO, MT, NE, NJ, NM, OR, PA, UT, WA, WY; **P. plumbaria** (0, I, III), IL, IA, MO, TX, WY to NM, CA, WA; **Uromyces acuminatus** var. **polemonii** (0, I), IL, IA, MN, MS, SD, WI.

VIRUS. **Angelonia Flower**; **Mosaic**, MD, NY, NC; **Tomato Spotted Wilt-Impatiens Serotype**, GA, FL; **Tobravirus**, IL, MI, MN.

WILT. **Verticillium albo-atrum**, MN, NY.

When gardeners talk about "rust" on phlox, they usually mean the physiological blight, for true rusts are uncommon on perennial summer phlox. Powdery mildew is general and especially disfiguring when plants are shaded or crowded with little air circulation. Sulfur dust is still good.

PHOENIX-TREE (*Firmiana simplex*)

BLIGHT, Web. **Rhizoctonia microsclerotia**, FL.

CANKER; Coral Spot. **Nectria cinnabarina**, OK.

ROT, Root. **Phymatotrichum omnivorum**, TX.

PHOTINIA (Christmasberry, Toyon and Oriental Species)

ANTHRACNOSE. **Gloeosporium** sp., MS.

BACTERIAL Fire Blight. **Erwinia amylovora**, CA, NJ.

BLIGHT, Leaf. **Fabraea maculata**, CA, LA.

DIEBACK. **Cytospora** sp.

LEAF SPOT. **Cercospora** sp., GA; **C. heteromeles**, CA, TX; **C. photiniae-serrulata**; **C. eriobotryae**; **Lophodermium heteromeles**, CA; **Phyllosticta heteromeles**, CA, TX; **Pestalotia** sp., NJ; **Septoria photiniae**,

CA, PA.

POWDERY MILDEW. **Podosphaera leucotricha**, CA; **Sphaerotheca pannosa**, OR.

ROT, Crown. **Phytophthora cactorum**, CA.

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX; **Phytophthora lateralis**, NC; **P. syringae**, NC.

RUST. **Gymnosporangium japonicum** (0, I), III on juniper; **G. clavipes**, MA.

SCAB. **Photinia photinicola** (*Spilocaea eriobotryae*), on leaves, berries, CA.

PHYSOSTEGIA (False Dragonhead)

BLIGHT; Southern Crown Rot. **Sclerotium rolfsii**, VA to OK, CT, KS, NJ, NY, WI.

DOWNY MILDEW. **Plasmopara cephalophora**, WI.

LEAF SPOT. **Mycosphaerella physostegiae**, GA, VA; **Septoria physostegiae**, IL, WI.

ROT, Stem. **Sclerotinia sclerotiorum**, ME.

RUST. **Puccinia physostegiae** (III), IN, MT, NH, NY.

VIRUS. **Tomato Spotted Wilt**, PA.

PICK-A-BACK (*Tolmiea*)

POWDERY MILDEW. **Sphaerotheca** sp., OR.

VIRUS. **Tomato Spotted Wilt**, PA.

PIERIS (Mountain, Japanese Andromeda)

BLIGHT, **Phytophthora ramorum**, OR; **P. tropicalis**, VA.

BLIGHT, Twig. **Cytospora** sp., OR.

DIEBACK. **Phytophthora** sp., PA; **Phytophthora cambivora**, NC.

LEAF SPOT. **Pestalotia** sp., CT, NJ; **Phyllosticta andromedae**, NJ; **P. maxima**, CT, NJ; **Alternaria tenuis**, RI.

LEAF SPOT, Tar. **Rhytisma andromedae**, FL, GA.

ROT, Root. **Armillaria mellea**, NJ.

PIGEON PEA (*Cajanus*)

PHYTOPLASMA, **Witches' Broom**. FL.
VIRUS. **Pigeon Pea Golden Mosaic**.

PINE (*Pinus*)

BLACK MILDEW. **Lembosia acicola**, CA.
BLIGHT, Brown Felt. **Herpotrichia nigra**, Northwest, on snow-buried foliage at high altitudes; **Neopeckia coulteri**, CA, MT.
BLIGHT, Brown Spot Needle. **Systremma** (*Scirrhia*) **acicola**, on hard pines in South, on Red pine, WI.
BLIGHT, Foliage. **Rhizoctonia solani**, VA.
BLIGHT, Needle. **Cytospora pinastri**, ME, NJ, PA; **Hendersonula pinicola**, NC, TN, WY; **Pullularia pullulans**, after insect injury; **Dothistroma pini**, IL, IA, NE, OH, OK, MD; **Septoria spadicea**, MN, NH, NY, VT, VA; **Lecanosticta** sp.
BLIGHT, Needle. **Dothistroma pini**, MN, MT, PA; **D. septospora**, PA, VT.
BLIGHT, Needle. **Lophodermella cerina**, AL, FL, LA, MS.
BLIGHT, Seedling. **Botrytis cinerea**, cosmopolitan; **Cylindrocladium scoparium**, NJ; **Fusarium subglutinans**, AL, NC, seedling mortality; **Rhizina undulata**, CA, ME, MN, northern Rocky Mts.; **Thelephora terrestris**, KS, ME, NJ, OH, PA, northern Rocky Mts.; **Scleroderris lagerbergii**, MI, NY, WI, also canker.
BLIGHT, Shoot. **Fusarium moniliforme** var. **subglutinans**, FL, GA; **Diplodia gossypina**, GA; **Gremmeniella abietina**, NH, NY; **Sphaeropsis sapinea**, NE.
BLIGHT, Snow. **Phacidium infestans**, occasional, New England; **P. convexum**, NC.
BLIGHT, Tip; Twig; Collar Rot. **Diplodia pinea** (*Sphaeropsis ellisii* and *S. Sapinea*), New England to CA, IA, KS, ND, SD, VA, WI. **Cenangium ferruginosum** (*C. abietis*), "pruning twig blight," widespread, sometimes secondary; **Monochaetia pinicola**.
CANKER. **Atropellis pinicola**, Northwest; **A. piniphila**, Northwest, AL, NM, TN; **A. tingens**, GA, MA, NH, NC, PA, VA; **A. arizonica**, AZ; **Caliciopsis pinea**, New England to SC, TN; **Dasyscyphus ellisiana**, on introduced pines in eastern states; **D. pini**, on five-needle pines, Pacific

Northwest, MI; **Nectria** spp., New England to NC, IA; **Rhabdospora mirabilissima**, of seedlings, NY; **Tympanis confusa**, VA.

CANKER. **Scleroderris lagerbergii** on red pine MI, MN, NY, VT, WI.

CANKER, Bark. **Aleurodiscus amorphus**, widespread; Felt, **Septobasidium** spp.

CANKER, Bleeding. **Sphaeropsis ellisii**, PA.

CANKER, Pitch. **Fusarium lateritium** f. sp. **pini**, FL, VA; **F. moniliforme** var. **subglutinans**, FL, NC; **F. circinatum**, AL, CA.

DAMPING-OFF. **Rhizoctonia solani** and **Pythium** spp., cosmopolitan; **Fusarium moniliforme** var. **intermedium**, GA

DECLINE. **Helicotylenchus multicinctus**, GA.

DIEBACK, Tip. **Sirococcus strobilinus**, CA, MI, MN, WI.

MISTLETOE. **Psittacanthus macrantherus**. Sinaloa, Mexico.

MISTLETOE, Dwarf. **Arceuthobium americanum**, Rocky Mt. states; Pacific Northwest; **A. campylopodum**, western dwarf, Rocky Mt. states to Pacific Coast, TX; **A. vaginatum**, southern Rocky Mt. states; **A. vaginatum** subsp. **cryptopodum**, CO; **A. cyanocarpum**, CO; OR, WY; **A. occidentale**, CA; **A. gilli**, AR; **A. vaginatum** subsp. **vaginatum**, AR; **A. hondurense**, Mexico; **Dwarf Mistletoe**; **Cladocolea cupulata** on **P. duglasiana** and **P. herrarie**, Mexico (Durango and Sinaloa).

NEEDLE CAST. **Bifusella linearis**, tar spot, widespread; **B. striiformis**, CA; **Elytroderma deformans**, also witches' broom, SD to AZ, CA, GA, WA; **Hypoderma desmazierii**; ME to NC, GA, WI; **H. hedgecockii**, Southeast; **H. lethale**, gray blight, on hard pines, New England to FL, LA; **H. pedatum**, CA; **H. pini**, CA, NV; **H. saccatum**, tar spot, CO, NM; **Hypodermella arcuata**, CA, OR; **H. ampla**, tar spot, Great Lakes states; **H. cerina**, CA; **H. concolor**, CO to ID, MT, OR; **H. lacrimformis**, CA, OR; **H. limitata**, CA; **H. medusa**, CA, CO; **H. montana**, CA to ID, OR; **H. montivaga**, CA to MT, OR; **Lophodermium nitens**, New England to GA and MI and Pacific Northwest, on five-needle pines; **L. pinastri**, widespread; **L. ponderosae**, CA; **Canavirgella banfieldii**, MI.

NEEDLE CAST. **Bifusella saccata**, CA, CO; **Hypodermella** sp., CA, OR; **Lophodermium durilabrum**, OR; **L. seditiosum**, MI.

NEEDLE DROOP. Abiotic inability of poor roots to acquire sufficient water, MI, MN, WI.

NEMATODE, Dagger. **Xiphinema americanum**.

NEMATODE, Lance. **Hoplolaimus coronatus**.

NEMATODE, Leaf. **Aphelenchoides fragariae**, FL.

NEMATODE, Pinewood. **Bursaphelenchus xylophilus**, vectored by pine sawyer beetle, IL, MO; also **B. lignicolus**, MO.

NEMATODE, Ring. **Criconemoides lobatum**; FL; **C. similis**, FL, NC.

NEMATODE, Root Knot. **Meloidogyne** sp., NM; **Meloidodera javanica**, FL; **M. floridensis**, on slash pine, FL.

NEMATODE, Sting. **Belonolaimus gracilis**.

NONPARASITIC. **Ozone Injury**; **Sulfur Dioxide Injury**; IN, NJ, WI; **Needle Curl**. High temperature; **Chlorotic Dwarf**.

ROT, Charcoal. **Macrophomina phaseoli**.

ROT, Heart; Wood. **Fomes** spp., general; **Fomes annosus**; **Lentinus lepideus**, widespread; **Polyporus** spp., widespread; **Poria** spp., **Lenzites saepiaria**; **Stereum** spp.; **Trametes** spp., widespread.

ROT, Hypocotyl. **Fusarium oxysporum**, CA; **F. oxysporum** var. **redolens**, MN, root lesions; **Longidorus** sp. (root damage and seedling stunting), GA.

ROT, Root. **Armillaria mellea**, widespread; **Ceratocystis wageneri**, OR, Pacific Northwest; **Clitocybe tabescens**, FL; **Cylindrocladium scoparium**, seedling blight, NJ, PA, WA; **C. clavatum**, FL; **Fusarium solani**, PA; **F. oxysporum**, PA; **F. avenaceum**, PA; **Phytophthora cactorum**, seedling blight, Northeast; **Phymatotrichum omnivorum**, TX; **Sparassis radicata**, MT to OR,WA; **Verticicladiella wagenerii**, CA, MT, western states; **V. procera**, FL, MN; **V. penicillata**, ID; **V. abietina**, ID.

ROT, Root. **Fomes annosus**, VA, WI; **Polyporus schweinitzii**, VA; **Phytophthora parasitica** var. **nicotianae**, CA; **P. citricola**, CA; **P. dreschleri**, NC; **Ionotus circinatus**, FL.

ROT, Root; Little Leaf. **Phytophthora cinnamomi**, NC, TN, VA, Dominican Republic.

ROT, Root; blue-stain fungi associated with roots; **Leptographium terebrantis**; **L. procerum**; **Ophiostoma** sp., **Graphium** spp., AL, TX.

RUST. **Coleosporium crowellii**, CA, NV, UT, NV; **Melampsora laricipopulina** (0, I), WA; II, III, on poplar; **M. medusae** f. sp. **deltoidae** (0, I), WA; II, III, on poplar.

RUST, Comandra Blister. **Cronartium comandrae** (0, I), swellings in twigs, trunks of hard pines; II, III on bastard toadflax, ND.

RUST, Cone. **Cronartium conigenum**, hypertrophy of cones, especially in South; II, III on oak; **C. strobilinum**; II, III on evergreen oaks.

RUST, Eastern Gall. **Cronartium quercuum**, galls on trunk, branches, witches' brooms on two- and three-needle pines East to Rocky Mts. especially Southeast; II, III on oak, rarely chestnut.

RUST, Fusiform. **Cronartium fusiforme**, swellings in trunk, branches, in South; II, III on evergreen oaks; **Cronartium quercuum** f. sp. **fusiforme**, NC.

RUST, Lodgepole Pine Blister; Western Fusiform. **Cronartium coleosporioides** (*Peridermium harknessi*) (0, I), swellings on twigs, branches; trunk cankers; widespread in West; II, III on painted-cup, birdbeak, owl-clover, wood-betony; **C. stalactiforme** (0, I); II, III on Indian paintbrush.

RUST, Needle. **Coleosporium apocyanaceum** (0, I), Southeast; II, III on *Amsonia*; **C. asterum** (*C solidaginis*) (0, I), on all two- and three-needle pines in eastern U.S., western form CO to MT, WA; II, III on aster, goldenrod, and other composites; **C. campanulae** (0, I), Northeast to IN, NC; (I, III on bellflower, loosestrife, Venus-looking-glass; **C. crowellii** (III), on pinon and limber pines, AZ, CO, NM; **C. delicatulum** (0, I), New England to FL and west to Great Plains; II, III on goldenrod; **C. elephantopodis** (0, I), NJ to FL, TX; II, III on *Elephantopus*; **C. helianthi** (0, I), NY to GA, OH; II, III on sunflower; **C. inconspicuum** (0, I), MD to GA, OH, TN; II, III on coreopsis; **C. ipomoeae** (0, I), NJ to FL, AZ, IL; II, III on morning-glory; **C. jonesii** (0, I), AZ, CO, NM; II, III on currant and gooseberry; **C. laciniariae**, NJ to FL; II, III on *Liatris*; **C. madiae** (0, I), CA, OR; II, III on composites; **C. minutum** (0, I), on loblolly and spruce pines, FL; II, III on *Forestiera*; **C. pinicola**, DE to NC, TN; **C. senecionis**, CO, RI; II, III on *Senecio*; **C. sonchiarvensis** (0, I), on Scotch pine, CT to NE; II, III on sow-thistle; **C. terebinthinaceae** (0, I), Southeast; II, III on *Parthenium* and *Silphium*; **C. vernoniae** (0, I), on two- and three-needle pines East and South; II, III on ironweed.

RUST, Pine-Pine Gall. **Endocronartium harknessii**, MN, MO, PA.

RUST, Piñon Blister. **Cronartium occidentale**.

RUST, Stem. **Cronartium appalachianum** (0, I), NC, TN, VA; II, III on *Buckleya*; **C. filamentosum**; **Peridermium weirii**.

RUST, Sweet-Fern Blister. **Cronartium comptoniae**, swellings on trunk and branches of two- and three-needle pines from northeastern to central and Great Lakes states; II, III on sweet-fern and sweet gale.

RUST, Western Gall. **Endocronartium harknessii**, VA, also twig necrosis and witches' broom, MA, ND.

RUST, White Pine Blister. **Cronartium ribicola** (0, I), swellings on trunk and branches of eastern white pine from New England to MN, NM, VA; on western white pine in Pacific Northwest; on sugar pine, CA; on limber pine, ND, SD, WY; II, III on gooseberry, currant, CA; on whitebark pine, CA, CO, NV.

SOOTY MOLD. **Fumago vagans**; **Capnodium pini**, widespread; **Scorias spongiosa**.

White pine blister rust is, of course, our foremost disease of pines, and full details are given under Rusts. Black currants are banned entirely in infected areas, red currants within 300 feet of pines. Of the other possible rusts on various pines, the only one seen in northern gardens is the aster rust (*Coleosporium asterum*), which is slightly disfiguring to the needles but not very damaging to general health. Fusiform rust is serious in the South. Brown needles may be due to one of the needle blights or needle cast fungi and also to winter drying. New shoots of Austrian pine turn brown from Diplodia tip blight, which should not be confused with the common discoloration caused by the pine shoot moth.

VIRUS. **Tomato Spotted Wilt**, GA (in *P. elliottii, P. taeda, P. palustris*).

WITCHES' BROOM. **Elytroderma deformans**, CA.

PINEAPPLE (*Ananas*)

NEMATODE, Lesion. **Pratylenchus brachyurus**.

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

NONPARASITIC. **Spike**, Long Leaf, FL.

ROT, Leaf Base; White Leaf Spot. **Ceratocystis paradoxa**, FL.

VIRUS. **Pineapple Wilt-Associated**, HI.

WILT. Toxic effect of mealybug feeding.

PIPSISSEWA (*Chimaphila*)

LEAF SPOT. **Mycosphaerella chimaphilina**, NY, OR, PA, WA; **Septoria chimaphilae**, DE.

RUST. **Pucciniastrum pyrolae** (II, III), NY to NC, CA, MT, OR, TN, WA, WI.

PISTACHIO (*Pistacia*)

BLIGHT, ROT ROOT. **Rhizoctonia solani**, CA.
BLIGHT, Shoot. **Botrytis cinerea**, CA; **Sclerotinia sclerotiorum**, CA; **Botryosphaeria rhodina**, CA; **Fusicoccum** (formerly *Botryosphaeria*).
BLIGHT, Thread. **Pellicularia koleroga**, FL, TX.
LEAF SPOT. **Phyllosticta lentisci**, TX; **Septoria pistaciarum**, AZ, TX.
NEMATODE. **Meloidogyne** sp., CA; **Xiphinema index**, CA.
ROT, Root. **Phymatotrichum omnivorum**, AZ, CA, TX.
ROT, Sapwood. **Pleurotus ostreatus**, CA; **Schizophyllum commune**, CA.
WILT. **Verticillium albo-atrum**, CA.

PITCHER-PLANT (*Sarracenia*)

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Colletotrichum gloeosporioides**, NJ, TX; **Helminthosporium sarracenia**, secondary, MN; **Mycosphaerella sarraceniae**, GA, ME, MI, MN, MS, NY, PA, SC; **Pestalotia aquatica**, secondary, MD, MN.
ROT, Root. **Pythium graminicola**, NC; **Rhizoctonia solani**, TX.

PITHECELLOBIUM (Blackbead, Catsclaw)

BLIGHT, Twig. **Phomopsis** sp., FL.
LEAF SPOT. **Colletotrichum erythrinae**, TX; **Pestalotia funerea**, TX; **Phyllosticta pithecolobii**, TX.
NEMATODE. **Meloidogyne** sp.
RUST. **Ravenelia gracilis** (0, I, II, III), TX; **R. pithecolobii** (II, III); **R. siderocarpi** (II, III), TX.

PITTOSPORUM

BLIGHT, Southern; Wilt. **Sclerotium rolfsii**, FL, TX.
BLIGHT, Thread. **Pellicularia koleroga**, LA; **Rhizoctonia ramicola**, FL.
LEAF SPOT, Angular. **Cercospora pittospori**, FL, LA, SC to TX; **Phyllosticta** sp., AL; **Alternaria tenuissima**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp.

ROT, Foot. **Diplodia** sp., FL.

ROT, Root. **Phymatotrichum omnivorum**, TX.

VIRUS. **Mosaic**, undetermined, CA; **Rough Bark**, undetermined, CA; **Variegation**. Variegated forms may be due to a virus.

WILT. **Verticillium albo-atrum**, CA.

PLANE-TREE, SYCAMORE (*Platanus*) (American Sycamore, *P. occidentalis*; California Sycamore, *P. racemosa*; London Plane, *P. acerifolia*; and Oriental Plane, *P. orientalis*)

ANTHRACNOSE; Leaf and Twig Blight. **Gnomonia platani** (*G. veneta, Gloeosporium platani, G. nervisequum*), general.

BACTERIAL Scorch. **Xylem limited Rickettsialike** bacteria, DC, LA, TX.

BLIGHT, Leaf. **Phloeospora multimaculans**, IN, TX.

BLIGHT, Twig; Canker. **Massaria platani**, CA, GA, IN, IA, KS, NJ.

CANKER. **Dothiorella** sp., NY; **Botryodiplodia theobromae**, MS; **Hypoxylon tinctor**, GA, LA, NC.

CANKER Stain; London Plane Blight. **Ceratocystis fimbriata** f. sp. **platani**, DE, MD, MS, MO, NJ, NY, NC, OH, PA, TN, VA, WV.

LEAF SPOT. **Cercospora platanicola** (*Mycosphaerella platanifolia*) NC to GA, IA, TX; spermatial stage is **Phyllosticta platani**; **Mycosphaerella stigmina-platani**, NC; **Septoria platanifolia**, GA, IA, MD, SC, TX, WV; **Stigmella platani-racemosae**, CA; **Cristutariella pyramidalis**, FL; **Tubakia dryina**, LA.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, NM, OK, TN, TX.

NONPARASITIC. **Rosy canker**. Illuminating gas in soil, MD, NJ, NY. **Decline**. Moisture deficiency, MS.

POWDERY MILDEW. **Microsphaera alni**, widespread; **Oidium obductum**, PA, VA, WV; **Phyllactinia corylea**, IN.

ROT, Heart, Trunk. **Fomes** spp.; **Steccherinum** (*Hydnum*) **erinaceus**, sometimes on living trees.

ROT, Root. **Armillaria mellea**, MD, TX, WV; **Phymatotrichum omnivorum**, AZ, TX,; **Phytophthora cinnamomi**, MD; **Clitocybe tabescens**, CA; **C. olearia**.

ROT, Wood. **Daedalea** spp., widespread; **Sterum** spp.; **Polyporus** spp.

The canker stain of London plane and American sycamore flared up in epidemic form around Philadelphia in 1935, killing thousands of street and

ornamental trees from Newark to Baltimore before it was learned the fungus was spread in pruning and in tree paint as well as by certain beetles. Pruning is now restricted to winter months, and a disinfectant is added to the wound dressing. Sycamore anthracnose is serious in wet seasons, particularly when the mean daily temperature for 2 weeks after bud-break is below 55°F.

PLANTAIN, Common (*Plantago*)

VIRUS. **Tomato Ringspot**, PA; **Plantago Mottle**, NY; **Ribgrass Mosaic**, NY.

PLATYCODON (Balloon-Flower)

BLIGHT. **Phytophthora cactorum**, MN.
ROT, Root. **Rhizoctonia solani**, CT, PA; **Phymatotrichum omnivorum**, TX.

PLUM (GARDEN), PRUNE (*Prunus domestica*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, widespread.
BACTERIAL Fire Blight. **Erwinia amylovora**, occasional, OR, WA.
BACTERIAL Leaf Spot; Black Spot. **Xanthomonas pruni**, eastern and southern states to WI, TX.
BACTERIAL Shoot Blight; Gummosis. **Pseudomonas syringae**, CA.
BLACK KNOT. **Dibotryon morbosum**, widespread except far West.
BLIGHT, Blossom, Twig. **Monilinia laxa**, CA, OR, WA; **Botrytis cinerea**.
BLIGHT, Thread. **Pellicularia koleroga**, LA.
BLIGHT, Twig. **Diplodia** spp., secondary.
BLOTCH, Leaf. **Phyllosticta congesta**, GA, TX.
CANKER. **Phytophthora cactorum**, CA, IN; **Ceratocystis fimbriata**, CA; **Valsa** (*Cytospora*) **leucostoma**, dieback, widespread.
LEAF CURL; Witches Broom. **Taphrina** spp., occasional; **T. communis**, plum pockets; **T. pruni**, pockets, bladder plums; **T. insititiae**.
LEAF SPOT; Shot Hole. **Cercospora circumscissa**, CA, FL, MA, TX, WA; **Coccomyces prunophorae**, widespread; **Coryneum carpophilum**, CA to ID and WA; **Phyllosticta circumscissa**, IA, WA; **Septoria pruni**, TX.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.

MISTLETOE. **Viscum album**, CA, on *Prunus salicina* ("Santa Rosa" Plum).

NEMATODE, Lesion. **Pratylenchus pratensis**; **P. vulnus**.

NEMATODE, Root Knot. **Meloidogyne** spp., FL, TX.

NONPARASITIC. **Brown Bark Spot**. Arsenical poisoning, MT.

Chlorosis. Alkaline soil, mineral deficiency, CA, FL.

Exanthema. Copper deficiency, CA, FL.

Gum Spot, Drought Spot. Irregular water supply, NY, Pacific Northwest.

Little Leaf. Zinc deficiency, CA, OR, WA.

Marginal Scorch. Fluorine injury, WA.

Myrobalan Asteroid Spot. Cause unknown, occasional.

Myrobalan Mottle. Genetic abnormality, occasional in seed stocks.

Wind Scab. Caused by developing fruit rubbing against other fruit, leaves and shoots during strong wind, CA.

POWDERY MILDEW. **Podosphaera oxyacanthae** var. **tridactyla**, occasional.

ROT, Brown; Blossom Blight. **Monilinia fructicola**, general.

ROT, Fruit. **Alternaria** sp., OR; **Botrytis cinerea**, CA, WA; **Cladosporium** sp., ID, OR; **Lambertella pruni**, CA.

ROT, Heart. **Fomes applanatus**, OR; **F. fulvus**, widespread; **Lenzites saepiaria**, Pacific Northwest; **Polyporus hirsutus**; **P. versicolor**, widespread.

ROT, Pink Mold. **Trichothecium roseum**, CA.

ROT, Root. **Armillaria mellea**, widespread; **Phymatotrichum omnivorum**, TX.

ROT, Silver Leaf. **Stereum purpureum**, WA.

RUST. **Tranzschelia discolor** (II, III), widespread, especially in South and Pacific Coast states; 0, I on anemone; **T. pruni-spinosae** (II, III); 0, I, on anemone, hepatica, thalictrum, buttercup.

SCAB. **Cladosporium carpophilum**, widespread.

VIRUS. **Plum Line Pattern**; **Plum White Spot**; **Prune Diamond Canker**; **Prune Constricting Mosaic**; **Prune Dwarf**; **Cherry Vein Clearing**; **Little Peach**; **Peach Mosaic**; **Peach Rosette**; **Peach Yellows**; **Ring Spot**; **Plum Rusty Blotch**; **Apricot Ring Pox**; **Stem Pitting**.

WILT; Seedling Black Heart. **Verticillium albo-atrum**.

Plums are even more subject to brown rot than peaches and take the same spray schedule. This includes insect control to avoid infection through feeding injuries. Black knot is sometimes conspicuous on twigs, but

diseased portions can be pruned out and a dormant lime-sulfur spray applied.

PLUM, WILD (*Prunus americana*)

BLOTCH Sooty. **Zygophiala jamaicensis**, IA
FLYSPECK, Fruit. **Pseudocercosporella** spp.

PLUMEGRASS (*Erianthus*)

ANTHRACNOSE. **Colletotrichum falcatum**, LA.
ERGOT. **Claviceps purpurea**, AL, OK.
LEAF SPOT; Mold. **Cladosporium erianthi**, SC; **Curvularia** sp., FL; **Helminthosporium** sp., FL; **Phyllachora erianthi**, tar spot, AL, FL, GA, SC.
RUST. **Puccinia virgata** (II, III), GA; **P. polysora** (II, III), 0, I unknown.

PLUMERIA (*Frangipani*)

LEAF SPOT. **Cercospora plumeriae**, FL.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium domingense** (II, III), FL; **C. plumeriae**, HI.

PODOCARPUS

NEMATODE, Burrowing. **Rodopholus similis**, FL.
ROT, Root. **Clitocybe tabescens**, FL.

POINCIANA (*Caesalpinia*)

ANTHRACNOSE. **Gloeosporium** sp., FL.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, FL.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Ravenelia humphreyana** (II, III), FL.

POINSETTIA (*Euphorbia pulcherrima*)

BACTERIAL Bract Spot. **Clavibacter cassiicola**, FL.

BACTERIAL Canker; Leaf Spot. **Clavibacter poinsettiae**, MD, NJ, NY, PA; **Pseudomonas viridiflava**, CA, FL.

BACTERIAL, Greasy Canker. **Pseudomonas viridiflava**, CA, FL.

BACTERIAL Leaf Spot. **Xanthomonas poinsetriaecola**, FL.

BACTERIAL Stem Rot. **Erwinia carotovora** pv. **chrysanthemi**, CT, MI, OH, PA, WV.

BLIGHT, Tip; Stem Canker. **Botrytis cinerea**, MO, TX, WA.

CANKER, Stem. **Fusarium solani**, WI.

LEAF SPOT. **Cercospora pulcherrimae**, TX; **Corynespora cassiicola**, LA.

NEMATODE, Root Knot. **Meloidogyne** sp., NY; **M. incognita**.

NONPARASITIC. **Chlorosis**. Possibly due to cloudy weather.
Stunt. Waterlogged soil.

POWDERY MILDEW. **Oidium** sp., CA.

ROT, Crown and Stem. **Phytophthora nicotianae** var. **parasitica**, FL.

ROT, Root. **Chalaropsis thielaviopsis**, IL; **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, AZ, TX; **Rhizoctonia solani**, FL, IL, NJ, TX; **Thielaviopsis basicola**, serious, common; **Pythium aphanidermatum**, PA; **P. irregulare**, PA; **P. ultimum**, PA.

ROT, Stem; Wilt. **Fusarium** sp., FL, NJ; **Pythium debaryanum**, OK; **P. perniciosum**, root rot, CA; **P. ultimum**; **Phytophthora** sp., NJ; **Sclerotinia sclerotiorum**, WA; **Amphobotrys ricini**, basal, LA.

RUST. **Uromyces euphorbiae** (0, I, II, III), OK, TX.

SPOT ANTHRACNOSE; Poinsettia Scab. **Sphaceloma poinsettiae**, FL.

VIRUS. **Poinsettia Mosaic**, WI.

Keep soil acid, pH 4.8 to 5, to reduce trouble with *Thielaviopsis. Rhizoctonia* is prevalent at high temperatures, *Pythium* at low. Steaming soil is safer than using chemicals.

POISON HEMLOCK (*Conium*)

VIRUS. **Alfalfa Mosaic**, WA; **Clover Yellow Vein**, WA.

POLEMONIUM (Jacobs-Ladder, Greek-Valerian)

LEAF SPOT. **Cercospora omphakodes**, PA; **Septoria polemonii**, MO, WI; **S. polemoniicola**, CT, IN, MO.

POWDERY MILDEW. **Golovinomyces cichoracearum**, UT; **Sphaerotheca macularis**, WA.

RUST. **Puccinia gulosa** (III), CA; **P. polemonii** (III), CA, ID, IN; **Uromyces acuminatus** var. **polemonii** (0, I), IL, IN, IA, WI.

VIRUS. **Tomato Spotted Wilt**, PA.

WILT. **Fusarium** sp., NJ; **Verticillium albo-atrum**, NJ.

POMEGRANATE (*Punica granatum*)

ANTHRACNOSE; Fruit Spot. **Colletotrichum** sp., FL.

BLIGHT, Thread. **Pellicularia koleroga**, FL.

BLOTCH, Leaf; Fruit Spot. **Mycosphaerella lythracearum**, FL to MS, TX.

NEMATODE. **Meloidogyne** sp., FL.

ROT, Fruit. **Alternaria** sp., CA; **Aspergillus niger**, AZ, CA, TX; **Botrytis cinerea**, gray mold, cosmopolitan; **Nematospora coryli**, dry rot, CA; **Penicillium expansum**, blue mold, cosmopolitan; **Coniella granati**, NC.

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

SPOT ANTHRACNOSE. **Sphaceloma punicae**, FL, LA, TX.

POND-SPICE (*Litsea*)

LEAF SPOT. **Cercospora olivacea**, GA.

POPLAR, ASPEN, COTTONWOOD (*Populus*)

BACTERIAL Limb Gall. **Agrobacterium tumefaciens**, CT, IA, MN, NE, TX.

BACTERIAL Wetwood. **Clavibacter humiferum**.

BLIGHT, LEAF. **Linospora tetraspora**, WA.

BLIGHT, Shoot. **Venturia populina** (*Didymosphaeria populina*), Northeast to WI; **V. tremulae**; **Colletotrichum gloeosporioides**, PA; **Glomerella cingulata**, WA, and leaf.

CANKER, Branch and Trunk. **Dothichiza populea**, most serious on Italian

varieties, widespread; **Hypoxylon pruinatum**, Southwest, Northeast and Great Lakes states, AZ, CA; **Nectria cinnabarina**; **N. galligena**; **Dothiora polyspora**, CO, NM, UT.

CANKER; DIEBACK. **Botryosphaeria ribis** var. **chromogena**, widespread, especially in the South; **Cytospora chrysosperma** (*Valsa sordida*); prevalent on ornamental poplars; **Valsa nivea**; **Ceratocystis tremulo-aurea**, Rocky Mts.; **C. fimbriata**, MN, PA; **Fusarium** (*Hypomyces*) **solani**, IA; **Phomopsis macrospora**, MS.

CANKER; DIEBACK. **Ceratocystis** sp., Rocky Mts., MN, PA on aspen.

CANKER, Sooty Bark. **Cenangium singulare**, Rocky Mts.

LEAF BLISTER, Yellow. **Taphrina aurea**, SC; **T. populina**, MS, New England to Great Lakes states; **T. johansonii**, catkin deformity, widespread; **T. populi-salicis**, CA, OR.

LEAF BLOTCH. **Septotinia populiperda**, ME, MD, MA, NY, VT.

LEAF BRONZE. **Apioplagiostoma populi**, Manitoba, Canada.

LEAF SPOT. **Marssonina** spp., widespread; **Mycosphaerella** (*Septoria*) **populicola**; **M. populorum** (*Septoria musiva*), also twig canker. **Phyllosticta** spp.; **Cercospora populina**, AL, LA, MO; **C. populicola**, TX; **Stigmina populi**, DE; **Marsonina brunnea**, WA and central U.S; **Septoria populicola**, WA.

LEAF SPOT; Ink Spot. **Ciborinia bifrons** (*Sclerotinia whetzelii*) in Northeast; **C. confundens** (*Sclerotinia bifrons*), CO to WY, OR, WA.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, NM, TX, **P. macrophyllum**

MISTLETOE, European. **Viscum album**, CA, on *Populus Fremontii* (Fremont Cottonwood) and *P. tremuloides* (Quaking Aspen)

NEMATODE, Dagger. **Xiphinema americanum**, SD, on cottonwood.

NEMATODE, Ring. **Criconemoides crotaloides**.

NONPARASITIC. **Chlorosis**. Iron deficiency, WY.

POWDERY MILDEW. **Uncinula salicis**, widespread; **Golovinomyces cichoracearum**, UT.

ROT, Heart. **Daedalea** spp., sometimes on living trees; **Fomes igniarius**, widespread; **F. pini**; **Pholiota adiposa** and **P. destruens**, New England states.

ROT, Root. **Armillaria mellea**, occasional; **Phymatotrichum omnivorum**, OK, TX; **Cylindrocladium scoparium**, of seedlings, GA.

ROT, Wood. **Collybia velutipes**, sometimes living trees, Rocky Mt. states; **Fomes** spp.; **Polyporus** spp.; **Lenzites saepiaria**, widespread.

ROT, Wound. **Schizophyllum commune**, cosmopolitan.

RUST, Leaf. **Melampsora bietis-canadensis** (II, III), New England to Great Plains; 0, I on hemlock; **M. albertensis** (II, III), CA, MT, NM; 0, I on Douglas-fir; **M. larici-populina** (II, III), WA, Quebec, Canada, Eastern North America; **M. medusae** (II, III), through U.S. except far South; 0, I on larch; **M. populnea** (III), CO, RI, Pacific Coast; **M. occidentalis** (II, III), MT to CA, IA, WA, WI; 0, I unknown.

SPOT ANTHRACNOSE. **Sphaceloma populi**, OK

VIRUS. **Poplar Decline**; **Poplar Mosaic**.

Cytospora canker is rather common on poplars lacking in vigor, but the Rio Grande cottonwood in the West is resistant. Avoid wounding, prune out twigs that have died back, and promote better growing conditions. Dothichiza canker may kill Lombardy poplars. Seriously diseased trees should be destroyed.

POPPY (*Papaver*)

ANTHRACNOSE. **Gloeosporium** sp. (*Glomerella cingulata*), NJ.

BLIGHT, Bacterial. **Xanthomonas papavericola**, CT, ME, MO, NJ, NY, OH, OR, VA.

BLIGHT, Gray Mold. **Botrytis cinerea**, AK, MD, WI.

LEAF SPOT; Pod Spot. **Cercospora papaveri**, AL, FL, TX; **Septoria** sp., IA.

NEMATODE, Leaf. **Aphelenchoides fragariae**, NJ.

NEMATODE, Root Knot. **Meloidogyne** sp.

POWDERY MILDEW. **Erysiphe polygoni**, OR.

ROT, Root, Stem; Damping-Off. **Rhizoctonia solani**, ID, IN, KS, ME, NJ, NY.

SMUT, Leaf. **Entyloma fuscum**, IA, ME, TX.

VIRUS. **Beet Curly Top**, TX; **Tomato Spotted Wilt**, CA.

WILT. **Verticillium albo-atrum**, NY.

POPPY-MALLOW (*Callirhoë*)

BROOMRAPE. **Orobanche ramosa**, TX.

LEAF SPOT. **Cercospora althaeina**, IL, KS, NE, WI; **Vermicularia sparsipila**, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Endophyllum tuberculatum** (III), IN, KS, NE, OK, TX; **Puccinia interveniens** (0 I), NE, NY, TX; II, III on Stipa; **P. schedonnardi**, CO, KS, NE, OK, TX, UT.
WILT. **Verticillium albo-atrum**, NY.

PORTULACA

BLIGHT, Stem. **Dichotomophthora indica**, VA.
DAMPING-OFF. **Rhizoctonia solani**, IL; **Helminthosporium** (**Bipolaris**) **portulacae**, NC.
NEMATODE, Root Knot. **Meloidogyne** sp., AL.
ROT, Black Stem. **Dichotomophthora portulacae**, CA, TX.
VIRUS. **Beet Curly Top**, CA; **Tomato Spotted Wilt**, NY
WHITE RUST. **Albugo portulacae**, MT to GA, MT, TX.

POTATO (*Solanum tuberosum*)

ANTHRACNOSE; Black Dot Disease. **Colletotrichum atramentarium** (*C. coccodes*), probably general after wilt; **Gloeosporium** sp., IN, OH.
BACTERIAL Blackleg. **Erwinia carotovora** pv. **atroseptica**, general.
BACTERIAL Canker. Vascular. **Clavibacter michiganense**, WY.
Also on *Solanum ciliatum, S. gilo, S. guineense, S. khasianum, S. nigrum, S. atropurpureum, S. avioculare, S. carolinense, S. indicum, S. nodiflorum, S. quitoense*.
BACTERIAL, MLO. **Aster Yellows**, Purple-Top.
BACTERIAL Ring Rot. **Clavibacter sepedonicum**, general.
BACTERIAL Soft Rot. **Erwinia carotovora** and **E. aroideae**, cosmopolitan in transit and market.
BACTERIAL Wilt. **Pseudomonas solanacearum**, chiefly in the South; **Ralstonia solanacearum**, race 3, biovar2, WI.
BLIGHT, Early. **Alternaria solani**, general.
BLIGHT, Late. **Phytophthora infestans**, general, common in Northeast, Middle Atlantic and North central states, occasional elsewhere, FL.
BLIGHT, Southern. **Sclerotium rolfsii**, NC to FL, AZ, OH.
BLOTCH, Leaf. **Cercospora concors**, GA, IN, MI, NY.
DODDER. **Cuscuta** sp., DE, NE, NJ, WA.

LEAF SPOT. **Ascochyta lycopersici**, OR.

NEMATODE, Golden. **Heterodera rostochiensis** (**Globodera rostochiensis**), DE, NY.

NEMATODE, Lesion. **Pratylenchus brachyurus**; **P. scribneri**; **P. negelectus**; **P. penetrans**, NY; **P. penetrans** and **Verticillium dahliae**, interaction (stunting and rot), WA.

NEMATODE, Ring. **Criconemoides mutabile**.

NEMATODE, Root Knot. **Meloidogyne** spp., general; **M. arenaria**; **M. chitwoodi**, CO, TX, Pacific Northwest; **M. hapla**, Pacific Northwest.

NEMATODE, Sting. **Belonolaimus gracilis**; **B. longicaudatus**.

NEMATODE, Stubby-root, WA.

NEMATODE, Tuber. **Ditylenchus destructor**, ID.

NONPARASITIC. **Black Heart**. Oxygen deficiency.

Blackening after Cooking. Drought, heat, deficient light during tuber growth; potassium deficiency, chilling.

Blackening before Cooking. Mechanical injury.

Checking. Skin rough, scruf. Partly fertilizer injury, alkalinity.

Chlorosis; Tip blight, boron deficiency; Leaf drop, magnesium deficiency.

Dimple. Depression at bud end and **Dimple skin**, pits. Cause unknown.

Elephant Hide. Fertilizer burn, on Russet Burbank.

Fasciation (tubers and aerial parts). Probably genetic.

Giant Hill. Over-sized, late-maturing plants. Genetic factors.

Glassy End. Starch deficiency; high water content.

Growth Cracks. Fluctuating moisture.

Hollow Heart. Excessive soil moisture and fertility.

Hopperburn. Marginal necrosis from leafhoppers. General.

Internal Brown Spot. Various physiological factors.

Knobbiness, "second growth". Extreme fluctuations of soil moisture.

Lenticel Enlargement. Wet soil or oxygen deficiency.

Mahogany Browning. Low temperature, ME.

Marginal Browning, bronzing. Potassium deficiency.

Ozone . Purple-black specks from air pollution.

Pitting, Spot necrosis of tubers. Oxygen deficiency in storage.

Pointed Ends. Irregular growth conditions.

Psyllid Yellows. Insect injury, western states.

Ring Spot. Zonate, depressed lesions. Cause unknown.

Scald of tubers. Overheating, sunburn, frequent in South.

Spraing. Internal concentric necrosis. TRV or PMTV Virus.
Sprout Tubers; "Little Potato". Overheating in storage; planting in dry, cold soil.
Stem-End Browning. Vascular necrosis. Virus.
Stem Necrosis; Defoliation. Manganese toxicity in acid soil.
Tipburn. Abrupt transition from cool, moist to hot, dry weather, general.

PHYTOPLASMA, Aster Yellows. **Candidatus Phytoplasma asteris**, NE, TX.

PHYTOPLASMA. **Potato Purple Top**, OR, WA.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, KY, NJ; **Oidium** sp.; MD, NJ, OH, PA, UT, western U.S; **Leveillula taurica**, W

ROT, Charcoal. **Macrophomina phaseoli**, CA, GA, IL, OK, TX.

ROT, Dry. **Fusarium graminearum**, ND.

ROT, Gray Mold; Shoot Blight. **Botrytis cinerea**, AK, CT, ID, ME, OH.

ROT, Pink, Watery. **Phytophthora erythroseptica**, DE, ID, LA, ME, MA, OK, PA; **P. parasitica**, TX; **P. cryptogea**, TX.

ROT, Root. **Armillaria mellea**, CA, FL, MI, OR, WA, WI, WY; **Phymatotrichum omnivorum**, TX; **Helicobasidium purpureum**, MA, MT, NE, NY, ND, OK, OR, TX, WA.

ROT, Silver Scurf. **Spondylocladium atrovirens**, general but less frequent in the South.

ROT, Stem. **Sclerotinia** sp., FL, ME, SC; **S. minor**, CA; **S. sclerotiorum**, FL, MA, MT, NY, OR, TX, WA.

ROT, Stem. **Sclerotinia** sp., FL, ME, SC; **S. minor**, CA; **S. sclerotiorum**, FL, MA, MT, general.

ROT, Tuber. **Aspergillus niger**; **Fusarium** spp.; **F. solani**, jelly end-rot; **Gliocladium** sp., secondary; **Oospora pustulans**, skin spot; **Penicillium** spp., blue mold; **Phoma tuberosa**; **Phomopsis tuberivora**; **Phytophthora drechsleri**; **Rhizopus** spp.; **Trichothecium roseum**, pink mold; **Xylaria apiculata**.

ROT, Tuber Sprout. **Fusarium sambucinum**, MI.

ROT, Watery Leak. Chiefly **Pythium debaryanum**, common in West; **Pythium** spp.

SCAB. **Streptomyces scabies**, general; Powdery Scab, **Spongospora subterranea**, AK, ND; Russet Scab, **Streptomyces** sp.

VIRUS. **Apical Leaf Roll**, unidentified; **Potato Aucuba Mosaic**; **Potato Calico** strain of **Alfalfa Mosaic**; **Potato Crinkle**; **Mild Mosaic** (Virus

X plus A); **Green Dwarf**; **Beet Curly Top**; **Potato Leaf Roll**, general; **Potato Leaf Rolling Mosaic**; **Mottle** (Potato Virus X); **Potato Rugose Mosaic** (Potato Virus Y), general; **Potato Spindle Tuber** (viroid), general; **Potato Vein Banding**; **Potato Witches' Broom**; **Potato Yellow Dwarf**; **Potato Yellow Spot**; **Tobacco Ring Spot**; **Potato Corky Ring Spot** (Tobacco Rattle); **Potato Virus M**; **Potato Virus S**, general; **Tobacco Veinnal Necrosis**, Pacific Northwest; **Potato Virus A**, WA; **Tomato Spotted Wilt**, NC; **Potato Mop-Top**, ME; **Impatiens Necrotic Spot**, NY.

WART, Potato. **Synchytrium endobioticum**, MD, PA, VA; see under Galls; Prince Edward Island, Canada.

WILT. **Verticillium albo-atrum**, widespread.

WILT; Stem-end Rot. **Fusarium** spp.; **F. oxysporum**, general but more frequent East and South.

Potato growing is a highly specialized business not well adapted to most small gardens. Use certified seed, resistant varieties where possible. Control insects spreading virus diseases.

POTENTILLA (*Cinquefoil*)

DOWNY MILDEW. **Peronospora potentillae**, IA, NJ, TX.

LEAF SPOT. **Fabraea dehnii**, IA, NY, VT; **Marssonina potentillae**, CA, CO, MA, MI, NM, NY, WI; **Phyllosticta anserinae**, IL; **Ramularia arvensis**, WI.

POWDERY MILDEW. **Erysiphe polygoni**, CO; **Sphaerotheca macularis**, CO, WI.

RUST. **Phragmidium andersonii** (I, II, III), general.

VIRUS. **Tomato Ringspot**, NY.

POTHOS (*Epipremnum*)

ROT, Petiole, Leaf, Crown. **Phytophthora capsici**, MA.

POTHOS, IVY-ARUM (*Scindapsus*)

BACTERIAL Blight. **Pseudomonas cichorii**, FL.

NEMATODE, Burrowing. **Radopholus similis**, FL.

NEMATODE, Lesion. **Pratylenchus** sp.

NEMATODE, Root Knot. **Meloidogyne arenaria thamesi**; **M. incognita**.
ROT, Root. **Pythium splendens**, FL; **Rhizoctonia** sp., foot rot, MO.

PRENANTHES (Rattlesnake-Root)

DOWNY MILDEW. **Bremia lactucae**, IA, MA, MN.
GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Cercospora brunnea**, AR, NC, WI; **C. prenanthis**, AL,IN, KS; **C. tabacina**, WI; **Laestadia prenanthis**, AL; **Septoria nabali**, NY to IA, WI, ME to VA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, IL, MD, NC, PA; **Sphaerotheca macularis**, NY to AL, IL, MN, OH, PA.
RUST. **Puccinia atropuncta** (0, I), PA, VA; II, III on *Amianthium*; **P. dioicae** (0, I), IL, MN, NY, VA, WI; II, III on *Carex*; **P. insperata** (I, II, III), OR; **P. orbicula** (0, I, II, III), ME to TN, ND.

PRICKLY-ASH (*Xanthoxylum americanum*)

CANKER, Stem. **Diplodia natalensis**, TX.
LEAF SPOT. **Cercospora xanthoxyli**, IN, TX; **Septoria pachyspora**, IA, NE.
POWDERY MILDEW. **Phyllactinia corylea**, widespread.
ROT, White Heart. **Fomes igniarius**.
RUST. **Puccinia andropogonis** var. **xanthoxyli** (0, I), IA, KS, MO, NE, TX, WI; II, III on *Andropogon*.

PRICKLY-POPPY (*Argemone*)

DOWNY MILDEW. **Peronospora arborescens**, TX.
LEAF SPOT. **Alternaria lancipes**, KS, TX; **Gloeosporium argemonis**, KS, TX; **Septoria argemones**, NE, OK, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Aecidium plenum** (0, I), TX.

PRIMROSE (*Primula*)

BACTERIAL Leaf Spot. **Pseudomonas primulae**, CA.
BACTERIAL, MLO. **California Aster Yellows**.

BLIGHT, Gray Mold. **Botrytis cinerea**, frequent in greenhouses, occasional in gardens.

LEAF SPOT. **Ascochyta primulae**, WI; **Asteroma garretianum**, black spot, CO, UT; **Cercosporella primulae**, WA; **Colletotrichum primulae**, FL; **Mycosphaerella** sp., AZ; **Ramularia primulae**, CA, CT, DE, NY.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CA, MD, PA.

NEMATODE, Root Knot. **Meloidogyne** spp., occasional in greenhouses.

NONPARASITIC. **Chlorosis**. Excessive soil acidity or iron or magnesium deficiency.

POWDERY MILDEW. **Erysiphe polygoni**, CT, NJ, VA.

ROT, Root. **Pythium irregulare**, CA; **Rhizoctonia solani**, FL, IL, TX; **Phymatotrichum omnivorum**, TX.

ROT, Stem. **Alternaria** sp., CT; **Sclerotinia sclerotiorum**, MD.

RUST. **Puccinia aristidae** (0, I), ME; **Uromyces apiosporus**, CA, NV.

VIRUS. **Primrose Mosaic**; **Cucumber Mosaic**; **Tobacco Necrosis**; **Tomato Spotted Wilt**; **Impatiens Necrotic Spot**, NC.

PRIVET (*Ligustrum*)

ANTHRACNOSE; Canker; Dieback. **Glomerella cingulata**, general, especially on common privet.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, occasional.

BLIGHT, Leaf. **Ramularia** sp., NJ, WA.

BLIGHT, Thread. **Pellicularia koleroga**, FL.

DODDER. **Cuscuta** sp., FL.

GALL. **Phomopsis** sp., MD, TX; **P. ligustri-vulgaris**, blight, PA; **Phoma** sp., TX.

LEAF SPOT. **Cercospora adusta**, DE to AL, TX; **C. ligustri**, Gulf states; **Exosporium concentricum**, TX; **Phyllosticta ovalifolii**, MD, MS, TX; **Corynespora cassiicola**, FL.

LEAF SPOT, Algal. **Cephaleuros virescens**, Gulf states.

NEMATODE, Leaf. **Aphelenchoides fragariae**.

NEMATODE, Root Knot. **Meloidogyne** spp., southern states.

NONPARASITIC. **Chlorosis**. Manganese deficiency, FL.

PARASITIC Lichen. **Strigula elegans** and **S. complanata**, southern U.S., GA.

POWDERY MILDEW. **Nicrosphaeria alni**, IN, LA, NJ, OH, on *Ligustrum japonicum* (Wax-leaf Ligustrum).
ROT. **Rosellinia necatrix**, CA; **Ganoderma applanatus**, collar rot.
ROT, Root. **Armillaria mellea**, AR, CA, MS, TX; **Clitocybe monadelpha**, AR; **C. tabescens**, FL; **Phymatotrichum omnivorum**, AZ, OK, TX.
ROT, Wood. **Stereum hirsutum**, cosmopolitan; **Polyporus versicolor**, cosmopolitan.
SOOTY MOLD. Common after whiteflies in the South.
VIRUS. **Variegation**. Graft transmitted. **Chlorotic Spot**, LA.

PRUNELLA (Self-Heal, Heal-All)

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Gibberidea abundans**, tar spot, ME, WA; **Linospora brunellae**, AK, ID, WA; **Phyllosticta brunellae**, TX; **Ramularia brunellae**, IL, IN, NY, OH, TX, VA, WI; **Septoria brunellae**, general.
POWDERY MILDEW. **Golovinomyces cichoracearum**, PA; **Sphaerotheca macularis**, IL, IN, MD, MS, WA, WI.
ROT, Root. **Pythium palingenes**; **P. polytylum**, VA.
VIRUS. **Tomato Ringspot**, VT.

PULMONARIA

ROT, Petiole. **Sclerotium rolfsii** var. **delphinii**, IA.

PUMPKIN

► Squash.

PUNCTURE VINE (*Tribulus*)

VIRUS. **Tomato Spotted Wilt**, General.

PYRACANTHA (Firethorn)

BACTERIAL Fire Blight. **Erwinia amylovora**, widespread.
BLIGHT, Leaf. **Fabraea maculata**, LA.
BLIGHT, Silky Thread. **Rhizoctonia ramicola**, FL.

BLIGHT, Twig. **Diplodia crataegi**, PA.
CANKER, Felt Fungus. **Septobasidium cokeri** and **S. mariani**, on bark scales.
CANKER; DIEBACK. **Botryosphaeria ribis**, LA.
MISTLETOE, European. **Viscum album**, CA.
ROT, Root. **Armillaria mellea**, CA; **Phymatotrichum omnivorum**, TX.
SCAB. **Fusicladium pyracanthae**, widespread on leaves and fruit.
WILT. **Fusarium oxysporum**, FL.
Fire blight is the most common disease. It infects all species, but some are relatively resistant. Scab, aften disfiguring on berries, can be prevented by spraying at bud-break and 10 and 20 days later.

PYRETHRUM (*Chrysanthemum cinerariifolium, C. coccineum*)

BACTERIAL Fasciation. **Clavibacter fascians**, CT, MD.
BACTERIAL, MLO. **Aster Yellows**, KS, NJ, NY.
BLIGHT, Gray Mold. **Botrytis cinerea**, PA.
DAMPING-OFF. **Gloeosporium** sp., PA; **Pythium** sp., root rot, CO.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, NJ.
ROT, Stem. **Sclerotinia sclerotiorum**, VA.

PYROLA (Shinleaf)

BLIGHT, Gray Mold. **Botrytis cinerea**, MD.
LEAF SPOT. **Mycosphaerella chimaphilae**, MI; **Ovularia pyrolae**, WI; **Ramularia pyrolae**, WI; **Phyllosticta pyrolae**, DE, MT, WI; **Septoria pyrolae**, MI.
RUST. **Chrysomxya pirolata** (II, III), general from ME to MN and from MT to CA, AK; 0, I on spruce; **Pucciniastrum pyrolae** (II, III), general in West.

QUEEN ANNE'S LACE, FALSE (*Ammi majus*)

VIRUS. **Mosaic, Clover Yellow Vein Potyvirus**, FL.

QUINCE (*Cydonia*)

ANTHRACNOSE, Northwestern. **Neofabraea malicorticis**, OR, WA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general.
BACTERIAL Fire Blight. **Erwinia amylovora**, general.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, ME to NC; Pacific Coast.
BLIGHT, Dothiorella Twig. **Botryosphaeria ribis**, TX.
BLIGHT, Leaf; Black Spot. **Fabraea maculata**, general.
BLIGHT, Thread. **Pellicularia koleroga**, NC, Gulf states.
CANKER, Perennial. **Neofabraea perennans**, OR.
CANKER, Trunk. **Nectria galligena**, OR; Twig, **Valsa leucostoma**.
FRUIT SPOT. **Leptothyrella pomi**, MO; **Mycosphaerella pomi**, New England to OH.
LEAF SPOT. **Phyllosticta** sp., DE.
NEMATODE, Root Knot. **Meloidogyne** sp., TX.
POWDERY MILDEW. **Phyllactinia corylea**, VA; **Podosphaera leucotricha**, CA, WA; **P. oxyacanthae**, NY, WV to IN.
ROT, Bitter; Canker. **Glomerella cingulata**, eastern and central states southward.
ROT, Black; Canker; Leaf Spot. **Physalospora obtusa**, eastern states to AL, TX.
ROT, Brown. **Monilinia fructicola**, eastern states, MS, OR, TX; **M. laxa**, also blossom and twig blight, Pacific Coast.
ROT, Fruit. **Alternaria mali**, IN; **Botrytis cinerea**, occasional; **Cephalothecium roseum**, pink mold, occasional; **Penicillium expansum**, cosmopolitan; **Phoma cydoniae**, pale rot, IL, MI; **P. mali**, IN.
RUST. **Gymnosporangium clavariiforme** (0, I), leaves, fruit, stems, CT, ME, NH; III on juniper; **G. clavipes** (0, I), orange rust, quince rust, on fruit, stems; III on juniper; **G. gracile** (0, I); III on juniper; **G. libocedri** (0, I), fruit, stems, OR; III on incense-cedar; **G. nelsonii** (0, I), leaves, stems, AZ, CO; III on juniper; **G. nidus-avis** (0, I), leaves, fruit, stems, CT, NY; III on juniper.
SCAB. **Venturia pirina**, CT.
SPOT ANTHRACNOSE. **Elsinoë piri**, WA.

Quinces are subject to fire blight; infected branches should be cut out with the usual precautions. For leaf blight, spray when blossoms show pink, again when last of the petals are falling, and perhaps twice more at 2-week inter-

vals. Brown rot is not very important on quince. To prevent rust, remove nearby susceptible junipers or spray them in spring as spore horns are developing on galls. See under RUSTS.

QUINCE, FLOWERING, JAPANESE, CHINESE (*Chaenomeles*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, occasional.

BACTERIAL Fire Blight. **Erwinia amylovora**, occasional.

BLIGHT, Leaf. **Fabraea macula**, AL, CT, NJ, NY.

CANKER, Felt Fungus. **Septobasidium burtii**, MS; **S. mariani**, NC.

CANKER, Twig Blight. **Botryosphaeria ribis**, AL, TX; **Phoma** sp., MD, TX; **Physalospora obtusa**, TX, eastern states.

FRUIT SPOT. **Mycosphaerella pomi**, IL, MD, also leaf blotch.

LEAF SPOT. **Cercospora cydoniae**, AL, GA.

NEMATODE, Root Knot. **Meloidogyne** sp.

ROT, Brown. **Monilinia fructicola**, leaf blight, MI; **M. laxa**, also blossom and twig blight, CA.

RUST, Quince. **Gymnosporangium clavipes** (0, I), on stems; CT, NJ; III on juniper; **G. libocedri** (0, I), on leaves; III on incense-cedar.

RABBITBRUSH (*Chrysothamnus*)

LEAF SPOT. **Phloeospora bigeloviae**, CA.

POWDERY MILDEW. **Golovinomyces cichoracearum**, CA, MT, UT, WY; **Erysiphe polygoni** var. **sepulta**, CO, MT, UT, WY.

RUST. **Puccinia dioicae** (0, I), NM and CA; **P. grindeliae** (III), MT to NM, CA; **P. stipae** (0, I), MT to NM, CA; II, III on grasses.

SMUT, Inflorescence. **Thecaphora pilulaeformis**, AZ.

RADISH (*Raphanus*)

BACTERIAL Black Rot. **Xanthomonas campestris**, IN, IA, MI, NJ, NY, OH, PA, TX.

BACTERIAL, Phytoplasma. **California Aster Yellows**, CA; **Virescence**, ID, WA.

BACTERIAL Soft Rot. **Erwinia carotovora**, cosmopolitan.

BACTERIAL Spot. **Xanthomonas vesicatoria** pv. **raphani**, IN; **Xanthomonas campestris** pv. **armoraciae**, OH.

BLOTCH; Black Pod. **Alternaria raphani**, CA, MI, MN, NJ, OH, PA.

CLUB ROOT. **Plasmodiophora brassicae**, occasional in North, MA to NJ, MN, WA.

DAMPING-OFF. **Pythium debaryanum**, MA, MN, NJ, WY; **Rhizoctonia solani**, cosmopolitan.

DOWNY MILDEW. **Peronospora parasitica**, northeastern and central states to MS, CA, TX.

LEAF SPOT. **Alternaria brassicae**, gray leaf spot, CA; **A. oleracea**, black leaf spot, CT, NJ; **Cercospora cruciferarum**, AL, IL, MO, TX; **C. atrogrisea**, NJ.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, NY.

NEMATODE, Root Knot. **Meloidogyne arenaria**; **M. javanica**, AL, MS, OR, PA, TX.

NONPARASITIC. **Air Pollution**. NO_2, O_3, SO_2, NC.

POSTHARVST, Black Patch. **Alternaria raphani**, St. Catharines, Canada.

POWDERY MILDEW. **Erysiphe polygoni**, CA, MO, TX.

ROT, Black Root. **Aphanomyces raphani**, ME to FL, CA, IA, OK, OR; **Pythium aphanidermatum**, IN, KS, MA, MI, NY, OH, OK, PA, SC, WI.

ROT, Crown, Watery Soft. **Sclerotinia sclerotiorum**, CA, IN, MN, NJ, TX.

ROT, Pod. **Phoma lingam**, CA, FL.

ROT, Root. **Ascochyta** sp.; **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia aristidae** (0, I), AZ, CO.

SCAB. **Streptomyces scabies**, IN, MI, NJ, OH, TX, WI.

SCAB, ACID. **Streptomyces acidiscabies**, ME.

VIRUS. **Radish Mosaic**; **Beet Curly Top**; **Tobacco Streak**, CA; **Tomato Spotted Wilt** (on wild radish), GA.

WHITE RUST. **Albugo candida**, general.

WILT; Yellows. **Fusarium oxysporum** f. sp. **raphani**; **F. oxysporum** f. sp. **conglutinans**, CA.

Radishes are so easily grown in home gardens that not many gardeners worry about disease control. Seed should, however, be treated for damping-off and root rots.

RAGWEED (*Ambrosia*)

BACTERIAL Blight. **Pseudomonas syringae** pv. **tagetis**, WI.
DOWNY MILDEW. **Plasmopara halstedii**, ND.
GALLS, Stem. **Protomyces gravidus**, LA.
LEAF SPOT. **Phoma** sp.
ROT, ROOT. **Rhizoctonia solani**, TX.

RAIN-LILY (*Cooperia*)

LEAF SPOT. **Cercospora amaryllidis**, TX.
RUST. **Puccinia cooperiae** (0, I, II, III), TX.

RAMBUTAN (*Nephelium lappaceum*)

ROT, Fruit. **Gliocephabotrichum simplex**, HI; **G. bulbilium**, HI; **Lasmenia** sp., HI.

RANUNCULUS (Buttercup, Crowfoot)

BLIGHT, Gray Mold. **Botrytis cinerea**, CA, NY, WI.
BACTERIAL, NLO. **California Aster Yellows**.
BACTERIAL NECROTIC LESION, LEAF, STEM. **Xanthomonas campestris**, CA.
DOWNY MILDEW. **Peronospora ficariae**, occasional MA to MD, IA, MN; also CA.
GALL, Leaf. **Synchytrium anomalum**, IA; **S. aureum**, CA. IL, WI; **S. cinnamomeum**, WI.
LEAF SPOT. **Ascochyta infuscans**, WI; **Cercospora ranunculi**, IA, WI; **Cylindrosporium ficariae**, WA; **Didymaria didyma**, IL, IN, IA, MA, MI, MS, NY, WI; **Fabraea ranunculi**, CA, NE, NY, WI; **Ovularia decipiens**; **Ramularia aequivoca**, IL, IA, OR, WI; **Septocylindrium ranunculi**, IL, NY, WA, WI; **Septoria** sp.
NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, OR.
POWDERY MILDEW. **Erysiphe polygoni**, frequent in eastern and central states; **Sphaerotheca macularis**, CO.
ROT, Leaf. **Ceratobasidium anceps**, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Stem. **Sclerotinia sclerotiorum**, AZ, CA; **Pythium** sp., CA; **Sclerotium rolfsii**, CA.

RUST. **Puccinia andina** (III), IL, IN; **P. eatoniae** var. **ranunculi** (0, I), CT to SC, CA, CO, MS, ND; II, III, on *Sphenopholis*; **P. ranunculi** (III), AZ, CO, UT, WA, WY, **P. recondita** (0, I), WI to TX, CA, WA; III on *Hordeum*; **Uromyces dactylidis** (0, I), CO, MA, TX; **U. jonesii** (0, I, III), CA, CO, MT, WY.

SMUT, Leaf. **Doassansia ranunculina**, IN, WI; **Urocystis anemones**, IL, UT, WY.

SMUT, White. **Entyloma microsporum**, IL, IN, IA, KY, VA, WI; **E. ranunculi**.

VIRUS. **Beet Curly Top**; **Ranunculus Mottle**; **Ranunculus Mosaic**; **Impatiens Necrotic Spot**, NC; **Tomato Spotted Wilt**, PA.

RASPBERRY (*Rubus*)

ANTHRACNOSE; DIEBACK; Gray Bark. **Gloeosporium allantosporum**, OR, WA.

BACTERIAL Blossom Blight. **Pseudomonas** sp., OR.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general; **A. rubi**, cane gall, NY, PA to IL, OR, WI.

BACTERIAL Fire Blight; Flower and Twig Blight. **Erwinia amylovora**, ME, NH, PA, WA, WI.

BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, OR.

BACTERIAL, Witches' Broom. **MLO**, OR.

BLIGHT, Cane. **Leptosphaeria coniothyrium**, general; **Physalospora obtusa**, IA, MD, MI, MO, ND; **Sclerotinia** sp., NY.

BLIGHT, Spur. **Didymella applanata**, general.

CANKER; Cane Spot. **Ascospora ruborum**, MA, OR, WI.

CANKER; DIEBACK. **Glomerella cingulata**, AR, KY, MD, MI, MO, NJ, OH, RI, WV; **G. rubicola**, white bud, IL, NJ; **Botryosphaeria ribis**, FL; **Macrophoma rubi**, IL.

DODDER. **Cuscuta gronovii**, CT, IL, WI.

DOWNY MILDEW. **Peronospora rubi**, WA.

FRUIT SPOT, Fly Speck. **Leptothyrium pomi**, IN, KY, MA.

LEAF SPOT. **Cylindrosporium rubi** (*Sphaerulina rubi*), also cane spot, common East of Rocky Mts.; **Mycosphaerella confusa** (*Cercospo-*

ra rubi), NJ to FL, IL, TX; **M. rubi**, general; **Pezizella oenotherae**, MD, MO, VA; **Septoria darrowi** (perhaps same as *Cylindrosporium rubi*) **Stigmatea rubicola**, black leaf and cane spot, MT, NM, NY, VT, WI.

NEMATODE, Lesion. **Pratylenchus vulnus**.

NEMATODE, Sheath. **Hemicycliophora** sp.

NONPARASITIC. **Chlorosis**. Iron deficiency in West.

POWDERY MILDEW. **Phyllactinia corylea**, MI; **Sphaerotheca macularis**, Northeast, Northwest, CA, IL, MN.

ROSETTE, Double Blossom. **Cercosporella rubi**, IL, KY, MD, NY, PA.

ROT, Fruit. **Botrytis cinerea**, gray mold, cosmopolitan; **Phyllostictina carpogena**, MD; **Monilinia fructicola**, brown rot, IL; **Alternaria** sp., MA; **Rhizopus nigricans**, black mold, cosmopolitan.

ROT, Root. **Armillaria mellea**, OR, WA; **Rhizoctonia solani**, CO, ID, WA; **Xylaria** sp., WA; **Phytophthora erythroseptica**, Pacific Northwest.

RUST, Late. **Pucciniastrum americanum** (II, III), Northeast to ID, IL, NC, OH; 0, I on spruce.

RUST, Leaf. **Phragmidium rubi-idaei** (0, I, II, III), northeastern and central states to CO; Pacific Northwest.

RUST, Orange. **Gymnoconia peckiana** (0, I, III), on black raspberry, Northeast to MN, Pacific Northwest; **Kunkelia nitens** (I), IL, IN, MI, OH.

RUST, Yellow. **Kuehneola uredinis** (0, I, II, III), IL, PA, DE to WI.

SPOT ANTHRACNOSE. **Elsinoë veneta**, general but less common on red than black raspberry.

VIRUS. **Raspberry Leaf Curl**; **Red**; **Black Raspberry Necrosis**; **Raspberry Streak**; **Raspberry Yellow Mosaic**, general; **Tomato Ring Spot**, cause of crumbly fruit, NY; **Tobacco Ring Spot**, NC; **Raspberry Bushy Dwarf**, OH; **Black Raspberry Witches' Broom Phytoplasma**, OR.

WILT. **Verticillium albo-atrum**, MA to NJ, OH, OR, WA.

Virus diseases are important on raspberries and cannot be controlled by spraying. Purchase healthy plants and set, if possible, 500 feet away from old patches. Inspect at least three times the first year, roguing all diseased plants, after first searing them with a blow torch or flame thrower so aphids will not carry the virus to nearby healthy bushes. Plants seldom recover from Verticillium wilt and never from orange rust, which is systemic. Crown gall is important on red raspberries; if infected plants are found, raspberries should not be replanted in the same soil for several years.

RATIBIDA (Prairie Coneflower)

DOWNY MILDEW. **Plasmopara halstedii**, IA.

LEAF SPOT. **Cercospora ratibida**, KS, WI; **Physalospora lepachydis**, MT; **Ramularia rudbeckiae**, ID; **Septoria infuscata**, MI, MO, WI.

POWDERY MILDEW. **Golovinomyces cichoracearum**, ND, TX.

ROT, Violet Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.

RUST. **Uromyces perigynius** (0, I), ND, TX; II, III on *Carex*.

SMUT, White. **Entyloma compositarum**, NE, MI to IN, KS, MN.

RATTAN VINE (*Berchemia*)

RUST. **Puccinia coronata** (0, I), VA to LA; II, III on oats and wild grasses.

REDBUD, JUDAS-TREE (*Cercis*)

CANKER; DIEBACK. **Botryosphaeria ribis** var. **chromogena**, DE, MD, NJ, NC, TX, VA.

DODDER. **Cuscuta exaltata**, TX.

DOWNY MILDEW. **Plasmopara cercidis**, TN.

LEAF SPOT. **Cercospora cercidis**, OK; **Cercosporella chionea**, IL, IN, KS, NC; **Mycosphaerella cercidicola**, general; **Phyllosticta cercidicola**, IN, WV; **Pestalotia guepini**, IL.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Polyporus lucidus**, VA.

ROT, Wood. **Polyporus adustus**; **P. versicolor**; **Ganoderma lucidum** (*Polyporus lucidus*).

WILT. **Verticillium** sp., OH; of seedlings, **Cylindrocladium** sp.

WILT. **Verticillium albo-atrum**, DC, VA; **V. dahliae**, DC.

RED-BAY, SWAMP-BAY (*Persea borbonia*)

BLACK MILDEW. **Asterina delitescens**, VA to FL, TX; **Irenopsis martiniana**, AL, MS, TX; **Lembosia rugispora**, MS, NC; **Meliola amphitricha**, FL, MS; **Englerula carnea**, FL.

LEAF SPOT. **Cercospora purpurea**, GA to FL, MS; **Phyllosticta micropuncta**, MD to FL, TX; **Pestalotia** spp., general.

LEAF SPOT, Algal. **Cephaleuros virescens**, Gulf states.
ROT, Wood. **Polyporus hirsutus**; **P. mutabilis**.

REDWEED (*Melochia*)

CANKER, STEM. **Diaporthe phaseolorum** var. **caulivora**, LA.

RHEXIA (Deergrass, Meadow-Beauty)

LEAF SPOT. **Cercospora erythrogena**, AL DE, MS, TN; **Colletotrichum rhexiae**, DE; **Phyllosticta rhexiae**, FL.

RHODESGRASS (*Chloris gayana*)

LEAF STRIPE, Culm Stripe. **Helminthosporium hawaiiense**, FL.

RHODODENDRON

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, OH.
BACTERIAL Leaf Spot. **Pseudomonas cichorii**, GA.
BLIGHT. **Phytophthora ramorum**, CA, NC, OR, WA; **P. tropicalis**, VA.
BLIGHT, Bud, Twig. **Briosia azalea**, GA, NJ, NY, NC, PA, TN, VA.
BLIGHT, Cutting. **Cylindrocladium scoparium** and **C. floridanum**, FL, OH.
BLIGHT; Flower Spot. **Ovulinia azaleae**, CA, SC.
BLIGHT, Gray. **Pestalotia macrotricha**, general after winter injury.
BLIGHT, Silky Thread. **Rhizoctonia ramicola**, FL.
BLIGHT; Twig Canker. **Phomopsis** sp., CT, NJ, NY, OR.
CANKER; DIEBACK. **Botryosphaeria ribis**, MD, MA, NJ, NY; **Gloeosporium** sp., MD, NY; **Phytophthora cactorum**, MD, MA, NJ, NY, OH, PA, RI; **P. hedraiandra** (also leaf lesions), MN; **Glomerella cingulata**, MD; **Phytophthora cambivora**, NC.
DAMPING-OFF. **Alternaria** sp., CT; **Rhizoctonia solani**, CT, NJ, NY.
DODDER. **Cuscuta gronovii**, NJ.
GALL. **Exobasidium vaccinii**, leaf and shot, MA to FL, MS; **E. burtii**, yellow leaf spot, NJ; **E. vaccinii-uliginosae**, witches' broom, NJ.

LEAF SPOT. **Cercospora handelii**, FL, NJ, NC, VA; **Coryneum rhododendri**, NC, PA, TN, VA; **Cryptostictis mariae**, KY, NY, TN, VA; **Discosia artocreas**, secondary, MD, NY; **Guignardia rhodorae**, CT, MD, MA, NJ, NY, PA, VA; **Gloeosporium ferrugineum**, NC; **Hendersonia concentrica**, NC, TX, WV; **Lophodermium schweinitzii**, NY to NC, TX; **Pestalopezia rhododendri**, TN, WV; **Mycosphaerella clintoniana**, NJ, NY, NC, OR, WA; **Phyllosticta rhododendri**, NJ; **Physalospora rhododendri**, PA, TN, VA; **Phomopsis rhododendri**, NJ; **Septoria rhododendri**, ME, NC; **S. solitaria**, NJ; **Venturia rhododendri**, MD, VA; **Phytophthora inflata**, OH; **P. insolita**, OH.

LEAF SPOT, Tar. **Melasmia rhododendri**, AK.

NONPARASITIC. **Chlorosis**. Mineral deficiency, usually iron, widespread.

Sunscald; Windburn. Severe winter injury in exposed locations.

Walnut Toxicity. Poisoning by root emanation from *Juglans nigra*.

POWDERY MILDEW. **Microsphaera alni**, MD, NJ, NY.

ROT, Heart; Wood Rot. **Fomes annosus**, NC.

ROT, Root. **Armillaria mellea**, CA, NJ, NY; **Phymatotrichum omnivorum**, TX.

RUST. **Chrysomyxa ledi** var. **rhododendri**, CA, WA; **C. roahnensis** (II, III), NC, TN; 0, I on spruce; **C. piperiana** (II, III), CA, OR, WA; **Pucciniastrum vaccinii** (II), CT, NJ, RI.

SPOT ANTHRACNOSE. **Sphaceloma** sp., WA.

VIRUS. **Rhododendron Necrotic Ringspot**, OR.

WILT. **Phytophthora cambivora**, NC; **P. cinnamomi**, MD, NJ, NY, PA, OH, VA; **P. citricola**, OH, VA; **P. cactorum**, VA; **P. citrophthora**, VA; **P. nicotianae**, VA; **P. tropicalis**, VA; **P. hibernalis**.

Most rhododendron leaf spots are not worth worrying about. Some come after winter injury; some are definitely parasitic but not serious. Winter and early spring sun will turn some of the foliage brown. Do not prune out supposedly dead twigs and branches too soon; wait for new growth to start. An accumulation of matted wet leaves around the trunk fosters root and collar rot. Be cautious in the use of aluminum sulfate to acidify soil; sulfur is somewhat safer.

RHOEO

VIRUS, **Tobacco Mosaic**, MD.

RHUBARB (*Rheum*)

ANTHRACNOSE. **Colletotrichum** sp., IL, MO, PA, WV, WI.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, IA, MA, NY.
BACTERIAL Soft Rot. **Erwinia carotovora**, occasional in market; **E. rhapontici**, crown rot, OK.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, MS, TX, VA.
DAMPING-OFF; Crown Rot. **Pythium** spp., CA, MD.
DOWNY MILDEW. **Peronospora rumicis**, CA.
LEAF SPOT. **Ascochyta rhei**, eastern and central states to MS, KS; **Alternaria** sp., CA, MN, NE, NJ, PA; **Cercospora** sp., DE, MD, NE; **C. rhapontici**, IL; **Cladosporium** sp., CA, WA; **Macrophoma straminella**, general; **Ramularia rhei**, CA; **Septoria rhapontici**, IA.
NEMATODE, Root Knot. **Meloidogyne** spp., CA, MD, NY, OK.
NONPARASITIC. Crack Stem. **Boron Deficiency**, WA.
ROT, Gray Mold. **Botrytis cinerea**, serious in greenhouses.
ROT, Root. **Armillaria mellea**, CA, TX; **Phymatotrichum omnivorum**, AZ, TX; **Phytophthora cactorum**, crown rot, CA, MO, OK, PA; **P. parasitica**, IL, KS, LA, MD, MO, NY, TX, VA; **Rhizoctonia solani**, CA, CT, IL, MN, MO, NY, OK, TX, WA.
RUST. **Puccinia phragmitis** (0, I), CA, MN, NE; II, III on *Phragmites*.
VIRUS. **Rhubarb Chlorotic Ring**; **Turnip Mosaic**, AK; **Beet Curly Top**.

Macrophoma leaf spot is common but seldom calls for control measures beyond removal of old stalks in late fall. Plants with crown rot should be dug and burned.

RIBBON-BUSH (*Homalocladium*)

POWDERY MILDEW. **Erysiphe polygoni**, NY, PA, WI.

RIBBON-GRASS (*Phalaris*)

ERGOT. **Claviceps purpurea**, NY.
LEAF BLOTCH (SPOT). **Stagonospora foliicola**, PA.
LEAF SPOT. **Helminthosporium catenarium**, PA on Reed Canary grass (*P. arundinacea*)
LEAF SPOT, Zonate Eye-Spot. **Helminthosporium giganteum**, MD.

RICE (*Oryzae sativa*)

LEAF, Blast. **Pyricularia grisea**, AR.
SMUT, False. **Ustilaginoidea virens**, LA.

RICE-PAPER PLANT (*Tetrapanax*)

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

ROCK-JASMINE (*Androsace*)

DOWNY MILDEW. **Peronospora candida**, KS.
LEAF SPOT. **Mycosphaerella primulae**, NM.
RUST. **Puccinia volkartiana** (III), AK.

ROCK-ROSE (*Cistus*)

ROT, Root. **Armillaria mellea**.

ROHDEA

VIRUS. **Tomato Spotted Wilt**, PA.

ROLLINIA

DIEBACK, Fruit Rot. **Glomerella cingulata**, FL.

ROMANZOFFIA

RUST. **Puccinia romanzoffiae** (III), OR.

ROSE (*Rosa*)

BACTERIAL Blast. **Pseudomonas syringae**.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, general.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, MD, PA, TX, VA, New England.

BLACKSPOT. **Diplocarpon rosae**, general; **Marssonina rosae**, MS.

BLIGHT, Blossom. **Botrytis cinerea**, cosmopolitan; gray mold on canes in storage; **Dothiorella** sp., LA, VA.

BLIGHT, Cane. **Physalospora obtusa**, CT, to AL, KS, TX; **Gloeosporium** spp., widespread.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, KS, TX.

BLIGHT, Thread. **Pellicularia koleroga**, FL, LA.

CANKER, Brand. **Coniothyrium wernsdorffiae**, MN, NY, PA (also reported from CO, IN, MS, TX, but probably mistaken for *C. fuckelii*).

CANKER, Brown. **Cryptosporella umbrina**, MA to FL, CA, ID, MI, NE, TX.

CANKER, Common, Graft. **Leptosphaeria coniothyrium** (*Coniothyrium fuckelii*), general; Graft, **C. rosarum**, CA, IA, MA, MN, NJ, PA, TX.

CANKER, Crown. **Cylindrocladium scoparium**, in greenhouses, MA to GA, IL, TX.

CANKER; DIEBACK. **Botryosphaeria ribis** var. **chromogena**, AL, MD, TX, VA; **Cryptosporium minimum**, OR, PA; **Diplodia** spp., probably secondary; **Griphosphaeria corticola** (*Coryneum microstictum*), NH to AL, ND; Pacific Northwest; **Nectria cinnabarina**, coral spot, MA to VA, AK, WA; **Cytospora** sp., KY, PA, VA, WA; **Didymella sepincoliformis**, MD; **Glomerella cingulata**, MD, NJ, VA; **Macrophoma** sp., TX, VA; **Botryodiplodia theobromae**, MN; **Trichothecium roseum**, MN.

DODDER. **Cuscuta indecora** and **C. paradoxa**, FL, TX.

DOWNY MILDEW. **Peronospora sparsa**, mostly under glass, ME to FL, CA, IA; reported outdoors in DE.

LEAF SPOT. **Alternaria** sp., VA to AL, TX; **A. brassicae** var. **microspora**, TX; **Cercospora puderi**, FL, GA; **Mycosphaerella rosicola** (*Cercospora rosicola*), general; **M. rosigena**, doubtfully distinct from *M. rosicola*, reported from South; **Monochaetia compta**, AK, IA, KS, MD; **Pezizella oenotherae**, also cane spot, NJ to FL, MI, TX; **Phyllosticta rosae**, NY to FL, IN; **P. rosae-setigerae**, IN; **Septoria rosae**, MS, NJ, SC.

MOLD, Black, of Grafts. **Chalaropsis thielavioides**, CA, IL, NY, PA on understock from OR and WA.

MOLD, Leaf and Bud. **Cladosporium** sp. and **C. fuscum**, AK, CA, MD, MN, MS, OK, TX.

NEMATODE, Dagger. **Xiphinema diversicaudatum**, greenhouses in Northeast; **X. americanum**; **X. krugi**.

NEMATODE, Leaf. **Aphelenchoides** spp.; Lance, **Hoplolaimus** sp.

NEMATODE, Lesion. **Pratylenchus pratensis**; **P. scribneri**; **P. vulnus**.

NEMATODE, Ring. **Criconemoides** sp.; Pin, **Paratylenchus** spp.

NEMATODE, Root Knot. **Meloidogyne** sp.; **M. hapla**.

NEMATODE, Spiral. **Helicotylenchus** spp.; Sheath, **Hemicycliophora** spp.

NEMATODE, Sting. **Belonolaimus gracilis**; Stubby Root, **Trichodorus** spp.

NEMATODE, Stylet. **Tylenchorhynchus** spp.

NONPARASITIC. **Boron Deficiency**. Leaves distorted, greenhouse.

Chlorosis. Iron deficiency, upper leaves yellow, with green veins; nitrogen deficiency, lower leaves pale; potassium deficiency, leaves grayish, may drop, stems weak.

Leaf Scorch. Marginal, potash deficiency. In greenhouses scorch may be boron and calcium deficiency.

Mercury Toxicity. In greenhouses when paint containing mercury used on sash.

Pedicel Necrosis. Collapse of flower stem, cause unknown.

Weed-killer Injury. Leaves fernlike, twisted when 2,4-D used in vicinity.

PETAL SPOT. **Bipolaris** (*Helminthosporium*) **setariae**, FL.

POWDERY MILDEW. **Podosonaera pannosa**, general; **S. macularis**, not readily distinguished from *S. pannosa*; **Phyllactinia corylea**, WA.

ROT, Root. **Armillaria mellea**, CA, MS, OR, TX, WA; **Clitocybe tabescens**, FL; **Fusarium** spp., occasional, especially in the South; **Phymatotrichum omnivorum**, AZ, TX; **Ramularia macrospora**, MD.

RUST. **Phragmidium americanum** (0, I, II, III), on leaves of cultivated and native roses, ME to NC, ND, TX; **P. montivagum** (0, I, II, III), on native species, SD to NM, AZ, WA; **P. mucronatum** (*P. disciflorum*), the common rust of cultivated roses, possibly on native species (0, I), on leaves and stems; II, III on leaves, eastern states to Rocky Mts.; Pacific Coast; **P. fusiforme** (*P. rosae-acicularis*) (0, I, II, III), on native species, MI to CO, CA, WY; **P. rosae-californicae** (0, I, II, III), on natives, AZ, CA, MT, OR; **P. rosae-pimpinellifoliae** (*P. subcorticium*) (0, I), on stems; II, III on leaves of brier and sweetbrier groups, northern U.S.; **P. rosicola** (III), CO, MT, NE, on native spp.; **P. speciosum** (0, I), on leaves and stems, III on stems of cultivated and native roses, general except far South.

SPOT ANTHRACNOSE. **Elsinoë rosarum**, ME to FL, KS, MI, MO, TX; Pacific Coast.

VIRUS. **Rose Mosaic** (in part **Prunus Necrotic Ring Spot** and **Apple Mosaic**), Pacific Coast and eastern states in greenhouses and in gardens on plants shipped from the West Coast; **Rose Rosette** (Witches' Broom), CA, KS, MD, MO; **Rose Streak**, MD, NJ, NY, TX, VA; **Rose Yellow Mosaic**, CA, IL, MD, NY, PA, VA; **Crinkle**. On Manetti understock, sometimes garden roses, Pacific Coast, MD, NY, PA, TX, VA; **Rose Leaf Curl**, CA; **Rose Spring Dwarf**, CA.

UNKNOWN. **Speckle**. Chlorotic flecks in leaves, not transmitted by grafting, MD, NJ, NY, PA, TX, VA.

WILT. **Verticillium albo-atrum**, AR, CA, IL, NJ, NY; probably widespread.

Blackspot, brown canker, powdery mildew, and rust are the big four diseases of garden roses. Blackspot is almost inevitable except in some dry western states, and shows up even there when overhead watering is substituted for the usual irrigation. It can be controlled by regular weekly spraying or dusting. Powdery mildew, a problem on the Pacific Coast, is increasing in eastern gardens. Brown canker and other cane diseases are best controlled at spring pruning, by cutting out infected canes and cutting other canes just above a bud, not leaving any stub to die back. Cankers are increased by excessive winter protection. Where temperatures permit, as in the Central Atlantic region, eliminate soil mounding and other special winter treatment.

Roses are sensitive to many chemicals; it is important to distinguish spray injury from blackspot and not increase the dosage because you think you are not getting control. Combination sprays or dusts should take care of most diseases, as well as insects, in one operation. The bacterial crown gall is occasionally present on plants purchased from a nursery. Ask for a replacement; do not contaminate your soil by planting such a bush.

ROSE – ACACIA (*Robinia hispida*)

LEAF SPOT. **Alternaria fasciculata**, ND.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROSELLE (*Hibiscus sabdariffa*)

ANTHRACNOSE, Pod Spot. **Colletotrichum gloeosporioides**, FL.

BLIGHT, Gray Mold. **Botrytis cinerea**, MD.

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Cercospora hibisci**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., TX.
POWDERY MILDEW. **Microsphaera euphorbiae**, AL, FL.
ROT, Fruit, Stem. **Fusarium** sp., FL; **Phytophthora parasitica**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX.

ROSE-GENTIAN (*Sabatia*)

ANTHRACNOSE. **Gloeosporium** sp., OK.
LEAF SPOT. **Cercospora sabbatiae**, DE, MS, NC, OK, TX.

ROSE – MALLOW (*Hibiscus palustris*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MS.
DIEBACK. **Colletotrichum hibisci**, NJ, NY, TX.
LEAF SPOT. **Ascochyta abelmoschi**, NY; **Cercospora kellermanii**, IN; **Phyllosticta hibiscina**, CT, FL, LA, MD, NJ, NY; **Septoria** sp., NJ.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia schedonnardi** (0, I), CT to AL, NE, TX; II, III on grasses.

ROSEMARY (*Rosmarinus*)

BLIGHT, AERIAL, ROT ROOT. **Rhizoctonia solani**, LA, OK.
ROT, Root. **Phymatotrichum omnivorum**, TX.

ROSE-OF-SHARON, SHRUB-ALTHAEA (*Hibiscus syriacus*)

LEAF SPOT. **Cercospora malayensis**, GA; **Phyllosticta hibiscina**, OK; **P. syriaca**, NY.
NEMATODE, Root Knot. **Meloidogyne** sp., MS, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Kuehneola malvicola** (II, III), Gulf states.

ROUGE-PLANT (*Rivina*)

LEAF SPOT. **Cercospora flagellaris**, FL, TX; **Septoria rivinae**, TX.
ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia raunkaerii** (0, I, II, III), FL, TX.

RUBBER-PLANT (*Ficus elastica*)

ANTHRACNOSE. **Glomerella cingulata**, general; **Gloeosporium** sp., WA.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA, TX.
CANKER; DIEBACK. **Physalospora rhodina**, GA.
LEAF SPOT. **Alternaria** sp., IN, OH, TX; **Leptostromella elastica**, NY, Northeastern states; **Mycosphaerella bolleana**, GA; **Phyllosticta** sp., MD, NY; **Phyllosticta roberti**, Gulf states, MD, NY; **Stemphylium elasticae**, secondary; **Trabutia** (*Phyllachora*) **ficuum**, black spot, FL.
NEMATODE, Leaf. **Aphelenchoides besseyi**, FL.
NEMATODE, Root Knot. **Meloidogyne** spp.; **M. incognita**.
NEMATODE, Spiral. **Helicotylenchus nannus**.

RUDBECKIA (Golden-Glow, Coneflower, Black-Eyed Susan)

BACTERIAL, MLO. **Aster Yellows**, NY, and **California Aster Yellows**, CA.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, NJ.
DOWNY MILDEW. **Plasmopara halstedii** IA, NE, NY, NC, ND, VA, WI.
GALL, Leaf. **Synchytrium aureum**, IL, WI.
LEAF SPOT. **Cercospora rudbeckiae**, NY; **C. tabacina**, IL, NY, WI; **Phyllosticta rudbeckiae**, IA, NY, WI; **Ramularia rudbeckiae**, VT to MS, CO, ID, MT, VA, VT, WV; **Septoria rudbeckiae**, DE, KS, NE, WA, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, CT.
RUST. **Aecidium batesii** (0, I), NE; **Puccinia dioicae** (0, I), MD, SD; **P. rudbeckiae** (III) TX; **Uromyces perigynius** (0, I), MD to MT; II, III on *Carex*; **U. rudbeckiae** (III), MT, MD to MS, NM, TX.
SMUT, White. **Entyloma compositarum**, IA, MO, OH, WI.

VIRUS. **Potato Yellow Dwarf**, NY; **Mosaic**, unidentified, IL, IN; **Bidens Mottle**, FL; **Tomato Spotted Wilt**, TX.
WILT. **Verticillium albo-atrum**, NY.

RUE ANEMONE (*Anemonella*)

LEAF SPOT. **Cercospora caulophylli**, MO.
POWDERY MILDEW. **Erysiphe polygoni**, IA.
RUST. **Puccinia recondita** (0, I), IN, IA, MO.
SMUT, Leaf and Stem. **Urocystis anemones**, NY.

RUELLIA

BLIGHT, Southern. **Sclerotium rolfsii**, LA.
LEAF SPOT. **Cercospora consociata**, AL, IL, IA, MS, MO.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia lateripes** (0, I, II, III), MD to FL, KS, MO, TX; **Uromyces ruelliae** (0, I, II, III), TX.

RUMEX (Garden Sorrel)

BACTERIAL, MLO. **California Aster Yellows**, CA.
GALL, Leaf. **Synchytrium anomalum**, IA.
LEAF SPOT. **Cercospora acetosellae**, LA, TX; **Phyllosticta** sp., NY; **Gloeosporium rumicis**, NY, TX; **Septoria pleosporioides**, TX.
NEMATODE, Ring. **Criconemella xenoplax**, SC.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Root. **Rhizoctonia solani**, TX.
RUST. **Puccinia acetosae** (II, III), ME to FL.
VIRUS. **Tomato Ringspot**, PA.

RUSSIAN KNAPWEED (*Acroptilon repens*)

LEAF SPOT. **Cercosporella acroptili**, MT.
RUST. **Puccinia acroptili**, CO, MT, WY.

RUSSIAN-OLIVE, SILVERBERRY (*Elaeagnus*)

CANKER. **Fusicoccum elaeagni**, IL, MO.

RUTABAGA

► Turnip.

SAFFLOWER (*Carthamus*)

ANTHRACNOSE; Blight. **Gloeosporium carthami**, IN, TX, VA.
BACTERIAL Blight. **Pseudomonas syringae**, CA.
BLIGHT. **Botrytis cinerea**; **Rhizoctonia** sp., NM.
LEAF SPOT. **Alternaria** spp., AZ, CA, IN, MT, NE, ND; **Septoria carthami**, IN, TX; **Stemphylium** sp., FL; **Cercospora beticola**, MT.; **Ramularia carthami**, **Ramularia cercosphaelloides**, Sonora, Mexico.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA.
ROT, Root. **Phytophthora drechsleri**, CA.
ROT, Stem; Wilt. **Sclerotinia sclerotiorum**, IN, ND, VA.
RUST. **Puccinia carthami** (II, III), CO, MA, MT, NE, ND.
VIRUS. **Cucumber Mosaic**, AZ, CA; **Turnip Mosaic**, CA.
WILT. **Fusarium oxysporum** f. sp. **carthami**; **Verticillium albo-atrum**.

SAGE (*Salvia*) (Includes Blue, Clary, Sauceleaf, Scarlet, Black Ornamental Forms)

BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Southern. **Sclerotium rolfsii**, IL.
DAMPING-OFF. **Pythium debaryanum**, OH; **Rhizoctonia solani**, CT, IL, NJ, OH.
DOWNY MILDEW. **Peronospora lamii**, IA, LA; **P. swinglei**, KS.
LEAF SPOT. **Cercospora salviicola**, OK, TX; **Ramularia salviicola**, OK.
NEMATODE, Leaf. **Aphelenchoides fragariae**, DE, NJ.
NEMATODE, Root Knot. **Meloidogyne** spp., AZ, NJ; **M. javanica**.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CA.
ROT, Charcoal. **Macrophomina phaseoli**, SC.

ROT, Root. **Fusarium oxysporum**, NC; **Phytophthora dreschleri**; **P. parasitica**, NC; **Phymatotrichum omnivorum**, TX; Stem, **Sphaeropsis salviae**, MS.

ROT, Root and Crown. **Phytophthora cryptogea**, CA.

RUST. **Aecidium subsimulans**, AZ; **Puccinia ballotaeflorae** (II, III), TX; 0, I unknown; **P. caulicola** (0, I, II, III), IA to TX, NM; **P. farinacea** (0, I, II, III), AL, AZ, KS, MS, MO, NE, OK, TX; **P. salviicola** (0, I, II, III), FL, TX; **P. vertisepta** (0, I, III), AZ, NM; **P. melliflora** (I, III), CA.

STEM SPOT, Lesion; Wilt. **Sclerotinia sclerotiorum**, ND.

VIRUS. **Tomato Spotted Wilt**.

SAGE-BRUSH (*Artemisia*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.

BLIGHT, Stem. **Sclerotium** sp., OR.

CANKER, Stem Gall, Black Knot. **Syncarpella tumefaciens**, CA, MT, NV.

DODDER. **Cuscuta** sp., TX.

DOWNY MILDEW. **Peronospora leptosperma**, CA, IA, KS, ND, WI.

LEAF SPOT. **Cercospora ferruginea**, WI; **C. olivacea**, NY; **Cylindrosporium artemisiae**, WA, WI; **Heterosporium** sp., AK; **Phyllosticta raui**, MT; **Ramularia artemisiae**, NY, WI; **Septoria artemisiae**, WA.

NEMATODE, Root Knot. **Meloidogyne** sp., AL.

POWDERY MILDEW. **Golovinomyces cichoracearum**, WI to NM, CA, WA.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia atrofusca**, IA to TX, CA, OR; II, III on *Carex*; **P. millefolii** (III), ND to TX, AK, CA, WA; **P. tanaceti** (0, I, II, III), WI to TX, CA, WA; 0, I, II, III on **Tanacetum** and II on chrysanthemum; **Uromyces oblongisporus** (III), WY.

SAINFOIN (*Onobrychis*)

DAMPING-OFF. **Rhizoctonia solani**, TX; **Sclerotium rolfsii**, TX.

NEMATODE, Root Knot. **Meloidogyne hapla**, WY.

ROT, Stem. **Rhizoctonia solani**, TX; **Sclerotium rolfsii**, TX.

ST. ANDREWS CROSS, ST. PETERSWORT (*Ascyrum*)

LEAF SPOT. **Cladosporium gloeosporioides**, AL.
RUST. **Uromyces triquetrus** (0, I, II, III), MS, NJ, TX.

ST. AUGUSTINEGRASS (*Stenotaphrum*)

ROT ROOT. **Gaeumannomyces graminis** var. **graminis**, FL, TX.
VIRUS. **Panicum Mosaic**, AR.

ST. JOHNSWORT (*Hypericum*)

BLACK KNOT. **Gibberidea heliopsidis**, MD.
BLIGHT, Leaf. **Rosellinia (Dematophora) necatrix**; **Diploceras hypericum** (stem and leaf), OR.
BLIGHT, Southern. **Sclerotium rolfsii**, SC.
GALL, Stem. **Sphaeropsis tumefaciens**, FL.
LEAF SPOT. **Cercospora hyperici**, IL; **Cladosporium gloeosporioides**, AL, NJ, NY, WI.
NEMATODE, Root Knot. **Meloidogyne** spp.
POWDERY MILDEW. **Golovinomyces cichoracearum**.
RUST. **Melampsora hypericorum** (II), MT; **Uromyces triquetrus** (0, I, II, III), ME to AL, and IA, TX, WI.

SALAL (*Gaultheria shallon*)

BLACK MILDEW. **Meliola** sp.
LEAF SPOT. **Dasyscyphus gaultheriae**, CA, OR, WA; **Mycosphaerella gaultheriae**, Pacific Coast, AK; **Pestalopezia brunneo-pruinosa**, CA, OR, WA; **Phyllosticta gaultheriae**, general.
LEAF, Stem Lesions. **Phoma exigua**, British Columbia, Canada.
POWDERY MILDEW. **Microsphaera alni**, OR.
SPOT ANTHRACNOSE. **Elsinoë ledi**, OR, WA.

SALPIGLOSSIS (Painted-Tongue)

BACTERIAL Canker, Vascular. **Clavibacter michiganense**, WY.
BACTERIAL, MLO. **California Aster Yellows**, CA.

NEMATODE, Lesion. **Pratylenchus pratensis**, NY.
NEMATODE, Root Knot. **Meloidogyne** sp., NY.
WILT. **Fusarium** sp., WA; **Verticillium albo-atrum**, NY.

SALSIFY (*Tragopogon*)

BACTERIAL, MLO. **California Aster Yellows**, CA; **Aster Yellows**, MD, NY, PA, WI.
BACTERIAL Soft Rot. **Erwinia carotovora**, CT, TX.
BLIGHT, Leaf. **Sporodesmium scorzonerae**, AL, MD, NY, PA, VA, WV.
BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Cercospora tragopogonis**, MT, OK; **Stemphylium botryosum**, NY; **Alternaria tenuis**.
NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., NY to AL, TX, WA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Root. **Phymatotrichum omnivorum**, AZ, TX; **Rhizoctonia solani**, TX, WA.
ROT, Stem, Crown. **Sclerotinia intermedia**, IL; **S. sclerotiorum**, IL.
VIRUS. **Beet Curly Top**; **Lettuce Mosaic**, NY.
WHITE RUST. **Albugo tragopogonis**, CA.
WILT. **Verticillium albo-atrum**, NY.

SALSIFY, BLACK (*Scorzonera*)

BACTERIAL, MLO. **California Aster Yellows**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
WHITE RUST. **Albugo tragopogonis**, CA.

SALT BUSH (*Atriplex*)

DOWNY MILDEW. **Peronospora farinosa**, MT, TX.
GALL, Leaf, Stem. **Urophlyctis pulposa**, ND, TX.
LEAF SPOT. **Cercospora dubia**, widespread; **Stagonospora atriplicis**, KS, NE, NJ, NY, PA.
NEMATODE, Root Knot. **Meloidogyne** sp., CA; root gall, **Heterodera schachtii**, UT.

RUST. **Puccinia aristidae** (0, I); II, III on grasses; **Uromyces shearianus** (0, I, III).
VIRUS. **Beet Curly Top**.

SALTGRASS (*Distichlis*)

BROWN STRIPE. **Bipolaris heveae**, CO.

SALVINIA (*Aquatic Fern*)

LEAF SPOT, Water-Soaked Lesions. **Rhizoctonia solani**, FL.

SANCHEZIA

ROT, Mushroom Root. **Clitocybe tabescens**, FL.

SAND-MYRTLE (*Leiophyllum*)

GALL, Leaf. **Exobasidium vaccinii**, NJ, NC.

SAND-VERBENA (*Abronia*)

DOWNY MILDEW. **Peronospora oxybaphi**, TX.
LEAF SPOT. **Heterosporium abroniae**, CA, TX.
RUST. **Puccinia aristidae**, AZ, CA, CO, NM; II, III on grasses.

SANDVINE (*Ampelanus*)

BLACK MILDEW. **Meliola bidentata**, NC.
DOWNY MILDEW. **Plasmopara gonolobi**, SC.
LEAF SPOT. **Cercospora gonolobi**, OK; **Septoria** sp., LA.
RUST. **Puccinia obliqua** (III), OK, TX.

SANDWORT (*Arenaria*)

LEAF SPOT. **Hendersonia tenella**, TX.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia arenariae** (III), CA, FL, MT, NY, TX, WI; **P. tardissima**, CO, NM, UT, WY; **Uromyces inaequialtus** (0, I, II, III), CO, UT.
SMUT, Anther. **Ustilago violacea**, ME, NH, NY, VT.

SANGUISORBA (Burnet)

LEAF SPOT. **Graphium sessile**, NY; **Ovularia bulbigera**, AK, IL.
POWDERY MILDEW. **Podosphaera oxyacanthae**, IA; **Sphaerotheca macularis**, AK, KS, NY, PA.
RUST. **Xenodochus carbonarius** (I, III), AK; **X. minor**, AK.

SANSEVIERIA (Bowstring-Hemp, Snake Plant)

BACTERIAL Soft Rot. **Erwinia aroideae** and **E. carotovora**, AZ, FL, MD, NJ.
LEAF SPOT. **Fusarium moniliforme**, FL, MO, WA; **Gloeosporium sansevieriae**, FL, WA.
NEMATODE, Lesion. **Pratylenchus** sp., CA.
NEMATODE, Root Knot. **Meloidogyne** sp.; **M. javanica**.
NONPARASITIC. **Wilt**. Overfertilization or toxic salts.
ROT. **Aspergillus niger**; **Fusarium** sp.

SAPODILLA (*Achras*)

GALL, Limb. **Pestalotia scirrofaciens**, FL, TX.
LEAF SPOT. **Phyllosticta** sp., FL; **Septoria** sp., FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Scopella** (*Uredo*) **sapotae** (II), FL.
SPOT ANTHRACNOSE. **Elsinoë lepagei**, FL.

SASSAFRAS

CANKER, Branch, Trunk. **Nectria** sp., CT to WV, MS.
CANKER; DIEBACK. **Physalospora obtusa**, NY to GA.
LEAF SPOT. **Septoria** sp., NY; **Actinothyrium gloeosporioides** (*Actinopella dryina*); **Cristulariella pyramidalis**; **Phyllosticta illinoiensis**, IL, MA; **P. sassafras**, NY to GA, TX, IL.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
POWDERY MILDEW. **Phyllactinia corylea**, MI.
ROT, Heart, Trunk. **Daedalea confragosa**, IN, NY; **Fomes igniarius**, OH, VA; **F. ribis**, MO.
ROT, Root. **Armillaria mellea**, PA; **Phymatotrichum omnivorum**, TX.
ROT, Wood. **Daldinia vernicosa**; **Hymenochaete agglutinans**; **Hypoxylon** spp.; **Polyporus** spp., sometimes on living trees; **Poria ferruginosa**; **Schizophyllum commune**, NY; **Trametes sepium**, IN.
VIRUS. **Mosaic**, NY; **Yellows**, TX, unidentified.
The undetermined yellows disease causes fasciation of tops, leafroll, and dwarfing of leaves.

SAURURUS (Swamp-Lily, Water Dragon)

GALL, Leaf. **Physoderma** sp., VA.
LEAF SPOT. **Cercospora saururi**, AL, FL, IL, IN, LA, NY, TX; **Ramularia saururi**, OK.
NEMATODE, Root Knot. **Meloidogyne** sp.

SAXIFRAGE (*Saxifraga*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Cercosporella saxifragae**, WI; **Phyllosticta saxifragarum**, WY; **Septoria albicans**, WI; **Ramularia** sp., AK.
POWDERY MILDEW. **Sphaerotheca macularis**, AK, CO, NY, PA, WY.
RUST. **Melampsora arctica** (0, I), AK, CO; II, III on willow; **Puccinia heucherae** (III), AK, MT to NM, ID, WA, WY, NY to IL, MT; **P. pazschkei** (III), ID, MT, WA; and var. **tricuspidatae**, CO, UT.
VIRUS. **Impatiens Necrotic Spot**, NC.

SCABIOSA

BACTERIAL, MLO. **Aster Yellows**, CT, NJ, NY, VA; and **California Aster Yellows**, CA.
BLIGHT, Southern. **Sclerotium rolfsii**.
POWDERY MILDEW. **Erysiphe polygoni**; **E. knautiae**, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, NY.
VIRUS. **Beet Curly Top**, CA.

SCARBOROUGH-LILY (*Vallota*)

LEAF SCORCH; Red Spot. **Stagonospora curtisii**, LA.

SCHEFFLERA (*Brassaia actinophylla* = *Schefflera actinophylla*)

BACTERIAL Blight. **Pseudomonas cichorii**, FL.
LEAF Spot. **Alternaria panax**, CA, FL.
NEMATODE, Root Knot. **Meloidogyne incognita**.
ROT, Stem, Leaf, Cutting. **Fusarium solani**, FL.
VIRUS. **Ghost Ring**; **Schefflera Ringspot**.

SCHEFFLERA, DWARF (*Schefflera arboricola*)

BACTERIAL Leaf Blight. **Pseudomonas cichorii**, FL.
LEAF SPOT. **Alternaria** sp. FL.

SCHRANKIA

RUST. **Ravenelia morongiae**, TX.
STEM SPOT. **Cercospora morongiae**, MS.

SCILLA (Squill)

NEMATODE, Bulb. **Ditylenchus dipsaci**, VA.
ROT, Blue Mold. **Penicillium gladioli**, on imported bulbs.

ROT, Bulb. **Sclerotium rolfsii**, WA.
SMUT, Flower. **Ustilago vaillantii**, MA, WA.
VIRUS. **Ornithogalum Mosaic**, NY.

SCINDAPSUS

▸ Pothos.

SEA-GRAPE, DOVE-PLUM (*Coccoloba*)

SPOT, Tar. **Phyllachora simplex**, FL.

SEA-KALE (*Crambe*)

LEAF SPOT, Black. **Alternaria oleracea**, VA.
ROT, Root; Damping-off. **Aphanomyces raphani**, WI.
VIRUS. **Beet Western Yellows Virus**, CA.
WILT, Yellows. **Fusarium oxysporum** f. sp. **conglutinans**, IN.

SEASHORE PASPALUM (*Paspalum*)

NEMATODE. **Helicotylenchus** sp., FL.
ROT, Root/Stolon. **Gaeumannomyces graminis** var. **graminis**. FL.

SEDUM (*Stonecrop*)

BLIGHT, Southern. **Sclerotium rolfsii**, KS, NJ, VA.
LEAF SPOT. **Septoria sedi**, IL, IA, ME, NY; **Pleospora** sp., NY; **Stemphylium bolickii**, FL.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Erysiphe sedi**, NY.
ROT, Stem. **Colletotrichum** sp. (*Vermicularia benficiens*), NY, VA; **Phytophthora** sp., NY; **Rhizoctonia solani**, IL, NJ.
RUST. **Puccinia rydbergii** (III), UT; **P. umbilici** (III), CO, WY.
VIRUS. **Tomato Spotted Wilt**, PA.
WILT. **Fusarium oxysporum** f. sp. **sedi**, CA.

SEMPERVIVUM (Houseleek)

ROT, Leaf and Stem. **Phytophthora parasitica**, NY.
ROT, Root. **Pythium** sp., IA.
RUST. **Endophyllum sempervivi** (III), MA, NJ, NY.

SENECIO (Groundsel)

BACTERIAL, MLO. **California Aster Yellows**.
GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Cercospora senecionicola**, WI; **C. senecionis**, TX; **Gloeosporium senecionis**, CA; **Phyllosticta garrettii**, OR, UT, WY; **Ramularia filaris**, CO, MT; **R. pruinosa**, CO, WY; **R. senecionis**, CA, CO; **Septoria cacaliae**, AL, IN, TX; **S. senecionis**, CA.
NEMATODE, Leaf. **Aphelenchoides ritzemabosi**.
POWDERY MILDEW. **Golovinomyces cichoracearum**, ID, MN, NE, VA, WA; **Sphaerotheca macularis**, CO, MT, UT, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, IL, NJ.
ROT, Stem. **Phytophthora** sp., NJ; **Sclerotinia sclerotiorum**, LA.
RUST. **Coleosporium occidentale** (II, III), CA, CO, ID, MT, OR, WA, WY; 0, I unknown; **C. senecionis** (II, III), CO, RI; **Puccinia angustata** var. **eriophori** (0, I), CT, IA, MN, NH, UT, VT; II, III on *Eriophorum* and *Scirpus*; **P. expansa**, CA, UT, WA, WY; **P. lagenophorae**, CA; **P. recedens**, CO, CT to NC, IA, TN, ND to OR, WA, WY; **P. dioicae** (0, I), NE, NM, TX; II, III on *Carex*; **P. stipae** (0, I), CO, NE, WY; II, III on *Stipa*; **P. subcircinata** (0, I, III), ID, NE, NV, NM, ND, UT, WA; **Baeodromus californicus** (III), CA.
SMUT, White. **Entyloma compositarum**, KS, MD, NE, PA, TX, WI.
VIRUS. **Tomato Spotted Wilt**.
WHITE RUST. **Albugo tragopogonis**, CA, CO, IN, MO, MT, NE, UT, WA.
WILT. **Fusarium** sp., NJ; **Verticillium albo-atrum**, WA.

SEQUOIA (Redwood and Giant Sequoia)

BLIGHT, Needle. **Chloroscypha chloromela**; **Cercospora sequoiae**, MD, PA; **Mycosphaerella sequoiae**; **Pestalotia funerea**, TX; **Phytophthora citrophthora**, also branch dieback, CA.

BLIGHT, Seedling. **Botrytis douglasii**, CA, OH, PA.
BLIGHT, Twig. **Phomopsis juniperovora**; **Botrytis cinerea**.
BURLS, Gall, on trunk. Cause unknown.
CANKER. **Botryosphaeria dothidea**, VA. [Redwood, Dawn] [U.S. Nat'l Arboretum, Washington, DC]; **B. dothidea** (= **B. ribis**), CA; **Phytophthora ramorum** (branch and leaf discolor), CA.
CANKER, Bark. **Dermatea livida**.
NEMATODE. **Meloidogyne hapla**, **M. incognita**, **M. javanica**, **Pratylenchus penetrans**, **P. vulnus**, **Xiphinema bakeri**, CA.
ROT, Charcoal. **Macrophomina phaseoli**.
ROT, Root. **Armillaria mellea**; **Phymatotrichum omnivorum**, TX.
ROT, Trunk; Heart. **Fomes annosus**; **Ganoderma sequoiae**; **Poria sequoiae**; **P. albipellucida**.
ROT, Wood. **Hymenochaete tabacina**; **Lenzites saepiaria**; **Merulius hexagonoides**; **Polyporus** spp.; **Schizophyllum commune**; **Stereum** spp.; **Trametes** spp.

SERIOCARPUS (White-Topped Aster)

RUST. **Coleosporium asterum** (II, III), CT; **Puccinia dioicae** (0, I), IN, NC, TN.

SESAME (*Sesamum*)

BACTERIAL Leaf Spot. **Pseudomonas sesami**, KS, TX.
BACTERIAL Wilt. **Pseudomonas solanacearum**, AZ.
BLIGHT. **Corynespora cassiicola**, MS, Southeast.
LEAF SPOT. **Alternaria sesami**, Southeast; **Cercospora sesami**, FL, GA, SC; **Cylindrocladium sesami**, FL, SC; **Helminthosporium sesami**, TX.
ROT, Charcoal. **Macrophomina phaseoli**, CA, TX.
WILT. **Verticillium albo-atrum**, NM.

SESUVIUM

NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL.
ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia aristidae** (0, I), TX; II, III on grasses.
WHITE RUST. **Albugo trianthemi**, TX.

SHALLOT (*Allium ascalonicum; A. porrum*, Leek)

BACTERIAL Blight. **Pseudomonas syringae** pv. **porri**, CA.
BACTERIAL, MLO. **Aster Yellows**, LA.
BLIGHT, Southern. **Sclerotium rolfsii**, LA.
BLOTCH, Purple. **Alternaria porri**, CA, LA, TX.
DOWNY MILDEW. **Peronospora destructor**, LA.
NEMATODE, Root Knot. **Meloidogyne** sp., TX.
ROT, Bulb and Basal, **Fusarium culmorum**, CA.
ROT, Neck; Gray Mold, **Botrytis allii**, LA; Smudge, **Colletotrichum circinans**, IL, LA, WI.
ROT, Pink Root. **Pyrenochaeta terrestris**, CO, LA, TX; **Fusarium solani**, TX.
ROT, White. **Sclerotium cepivorum**, LA, VA.
SMUT. **Urocystis cepulae**, MA.
VIRUS. **Mosaic**, unidentified; **Tomato Spotted Wilt**, GA.
Pink root and white rot are prevalent in Louisiana. Losses from white rot are heavy if plants are set late; September setting may give a good crop.

SHASTA DAISY (*Leucanthemum x Superbum*)

BACTERIAL Fasciation. **Clavibacter fascians**, CA.
LEAF BLOTCH. **Septoria leucanthemi**, CA, OR.
LEAF SPOT. **Cercospora chrysanthemi**, OK.
NEMATODE, Root Knot. **Meloidogyne** spp., AL, FL, MS.
ROT, Root. **Pythium** sp., NJ.
ROT, Stem. **Rhizoctonia solani**, MD; **Sclerotinia sclerotiorum**, MT, WA; **Fusarium roseum** and **F. solani**, TX.

SHEPHERD'S PURSE (*Capsella*)

BACTERIAL, Yellows. **Spiroplasma citri**, IL.

SHINING WILLOW (*Salix lucida*)

LEAF SPOT. **Septoria musiva**, Quebec, Canada.

SHORTIA (Oconee-bells)

LEAF SPOT. **Pezizella oenotherae**, NC, SC.

SIDA

BLIGHT, Southern. **Sclerotium rolfsii**, FL.
CANKER, Stem. **Diaporthe phaseolorum** var. **caulivora**, LA.
LEAF SPOT. **Cercospora sidicola**; **Colletotrichum malvarum**, KS, TX, UT; **Phyllosticta spinosa**, KS, TX; **Ramularia sidarum**, FL; **Sclerotinia minor** (bleached leaf and stem lesions), NC.
NEMATODE, Root Knot. **Meloidogyne** spp., AL, FL, MS.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia heterospora**, FL to TX, IN, MO; **P. lobata**, AZ, CA, NM, TX, UT; **P. schedonnardi**, NM.
VIRUS. **Abutilon Mosaic**, FL.

SILENE (Catchfly, Cushion-Pink, Campion)

BROOMRAPE. **Orobanche ramosa**, TX.
DAMPING-OFF. **Rhizoctonia solani**, IL.
DOWNY MILDEW. **Peronospora silenes**, IL, KS, NE, TX, WI.
LEAF SPOT. **Ascochyta silenes**, MT, OK, WI; **Marssonina delastrei**, WI; **Phyllosticta nebulosa**, MT, NY, WI; **Septoria dimera**, NE, WI; **S. silenes**.
RUST. **Uromyces silenes** (0, I, II, III), CA, IA, KS, MT, PA, WA; **U. suksdorfii**, CA, ID, NM, UT, WA; **Puccinia aristidae** (0, I), AZ, TX.
SMUT, Flower. **Sorosporium saponariae**, CO, NV, UT; **Ustilago violacea**, anther smut, CA, MT, NH, TX, VA, WA, WY.

SILK-TASSEL BUSH (*Garrya*)

BLACK MILDEW. **Lembosia lucens**, CA.

LEAF SPOT. **Cercospora garryae**, CA, TX; **Dothichiza garryae**, CA; **Phyllosticta garryae**, CA, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

SILPHIUM (Compass Plant, Indian-Cup)

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **tagetis**, WI.
DOWNY MILDEW. **Plasmopara halstedii**, IL, IA, WI to AR, KS, MN.
LEAF SPOT. **Ascochyta compositarum**, WI; **Cercospora silphii**, AL, IL, KS, TX, WV, WI; **Colletotrichum silphii**, WI; **Septoria alba**, IL, KS.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CT, MD.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, ME.
RUST. **Puccinia silphii** (III), NC to AL, TX, ND; **Coleosporium terebinthinaceae** (II, III), PA to FL, TX, KS; 0, I on pines; **Uromyces silphii** (0, I), OH to MO, KS and WI; II, III on *Juncus*.
SMUT, White. **Entyloma compositarum**, TX, WI.

SKIMMIA

VIRUS. **Tobacco Ring Spot**, NY.

SKULLCAP (*Scutellaria*)

LEAF SPOT. **Cercospora scutellariae**, IL, MS, MO, TX; **Phyllosticta decidua**, TX, WI; **Septoria scutellariae**, ME to IA, CA, CO, MS, OK.
POWDERY MILDEW. **Erysiphe galeopsidis**, IL, IN, IA, KS, MI, NY, OH, WI; **Microsphaera** sp., IL.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX.
ROT, Stem. **Botrytis cinerea**, WA.
VIRUS. **Alternanthera Mosaic**, FL, MD, PA.

SKUNK-CABBAGE (*Symplocarpus*)

BLIGHT, Leaf. **Botrytis streptothrix**, CT, IL, NJ, NY.
LEAF SPOT. **Cercospora symplocarpi**, MA to VA, IN, WI; **Septoria spiculosa**, MD, NY, PA, WI.

SKUNK VINE (Paederia foetide)

LEAF SPOT. **Pseudocercospora paederiae**, FL.

SLENDERFLOWER THISTLE (*Carduus*)

RUST. **Puccinia carduorum**, CA.

SMALL FLOWER GALINSOGA (*Galinsoga parviflora*)

ROT, Stem. **Whetzelinia sclerotiorum**, MD.

SMELOWSKIA

RUST. **Puccinia aberrans** (0, III), CO, MT, NE, UT, WA; **P. holboellii**, NV; **P. monoica**, CO, WY.

SMILAX (Greenbrier Cat-Brier)

For Florists' Smilax, ► Asparagus.

CANKER, Felt Fungus. **Septobasidium pseudopedicellatum**, FL.
GALL. **Synchytrium smilacis**.
LEAF SPOT. **Ascochyta confusa**, NY, WI; **Cercospora smilacina**, CT to FL, TX; **C. smilacis**, MA to FL, TX, and MN; **Colletotrichum smilacis**, IL; **Cylindrosporium smilacis**, AL; **Dothiorella smilacina**, MA to LA, TX; **Mycosphaerella smilacicola**, GA, SC; **Pestalotia clavata**, NY to AL, LA; **Phyllosticta subeffusa**, IL, KS, WV; **Ramularia subrufa**, IA, MS, NE, WI; **Septogloeum subnudum**, IL, WI; **Septoria smilacis**, WV; **Sphaeropsis cruenta**, IA; **Stagonospora smilacis**, CT to MD, ND, TX.
NEMATODE, Burrowing. **Radopholus similis**, FL.
POWDERY MILDEW. **Phyllactinia corylea**, MI.
ROT, Root. **Helicobasidium purpureum**, TX.
RUST. **Puccinia amphigena** (0, I), KS, MI, NE, ND; II, III on *Calamovilfa*; **P. arundinariae** (0, I), NC, SC; **P. macrospora** (0, I), DE, NJ, NY; II, III on *Carex*; **P. smilacis** (II, III), MA to FL, TX, and NE; 0, I on *Apocynum*.

SMITHANTHA

VIRUS. Tobacco Mosaic, CA, CT, DC, FL, OH, WA.

SMITHIANA

VIRUS. **Smithiana Potexvirus**.

SMOKE-TREE (*Cotinus*)

LEAF SPOT. **Cercospora rhoina**, AL; **Pezizella oenotherae**, MD; **Septoria rhoina**, CT, MA, NY, VA; **Gloeosporium** sp., IL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Pileolaria cotini-coggyriae**, GA, RI.
WILT. **Verticillium albo-atrum**, CT, IL, NE, NJ, NY.

SMOKE-TREE (*Dalea*)

LEAF SPOT. **Cercospora daleae**, KS.
MISTLETOE. **Phoradendron californicum**, CA to TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Pileolaria cotini-coggyriae**, AR.
RUST. **Puccinia andropogonis** (0, I), SD to KS; II, III on *Andropogon*; **P. paroselae** (II, III), CA.

SNAKEWEED (*Polygonum*)

NEMATODE, Foliar. **Aphelenchoides fragariae**, SC.
ROT, Root. **Pythium helicoides**, FL.

SNAPDRAGON (*Antirrhinum*)

ANTHRACNOSE. **Colletotrichum antirrhini**, general in eastern and southern states to CO and TX.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, NY.
BLIGHT, Gray Mold. **Botrytis cinerea**, cosmopolitan in greenhouses.

BLIGHT, Southern; Stem Rot. **Sclerotium rolfsii**, CA, FL, MS, NJ, NY, TX.

CANKER, Stem and Crown. **Myrothecium roridum**, IL.

DAMPING-OFF; Root Rot. **Pythium** spp., cosmopolitan; **Rhizoctonia solani**, also collar rot.

DODDER. **Cuscuta** sp., WA.

DOWNY MILDEW. **Peronospora antirrhini**, CA, NY, OK, OR, PA.

LEAF SPOT. **Cercospora antirrhini**, FL, IL.

LEAF SPOT; Stem Rot; Canker. **Phyllosticta antirrhini**, general in eastern and North central states also TX and WA.

NEMATODE, Lesion. **Pratylenchus pratensis**.

NEMATODE, Root Knot. **Meloidogyne** spp., general in South and in northern greenhouses; **M. javanica**, MD.

NEMATODE, Pin. **Paratylenchus penetrans**, CA.

NONPARASITIC. **Fasciation**. Probably genetic.

Tip Blight. Cause unknown CA, MD, OK, VA; injury from peach aphid.

PETAL SPOT. **Bipolaris** (*Helminthosporium*) **setariae**, FL.

POWDERY MILDEW. **Oidium** sp., MA, NY, PA.

ROT, Charcoal. **Macrophomina phaseoli**, OK.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Thielaviopsis basicola**, CT, NJ.

ROT, Stem; Wilt. **Fusarium** sp., perhaps secondary; CT, FL, GA, OK, TN, WA; **Phytophthora cactorum**, CA, IL, MN, NJ, NY; **P. cryptogea**, CA, OK; **P. parasitica**, GA; **Sclerotinia sclerotiorum**, CA, IN, MI, PA, TX; **S. minor**, CT.

RUST. **Puccinia antirrhini** (II, III), general; 0, I unknown.

VIRUS. **Cucumber Mosaic**, **Mosaic**, unidentified, KS, NY, OH, PA; **Ring Spot**, unidentified, OK; **Impatiens Necrotic Spot**, NC.

WILT. **Verticillium albo-atrum**, CA, CT, ME, MA, MN, NY, NJ, PA.

Rust is the most generally important disease and can be prevented, to some extent, by purchasing rust-resistant seed, but not all such seed is resistant to all strains of rust.

SNOWBERRY (*Symphoricarpos*)

ANTHRACNOSE; Black Berry Rot; Twig Canker. **Glomerella cingulata**, widespread, MA to VA, IL and WI.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD.

BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, IA.

LEAF SPOT. **Ascochyta symphoricarpophila**, NY; **Cercospora symphoricarpi**, MT, SD; **Phyllosticta symphoricarpi**, NM, NY, WA; **Lasiobotrys symphoricarpi**, black spot, CO, UT, WY; **Septoria oedospora**, CO; **S. signalensis**, WY; **S. symphoricarpi**, ND to CO, CA and WA.

POWDERY MILDEW. **Microsphaera diffusa**, general; **Podosphaera oxyacanthae**, WA.

ROT, Berry. **Alternaria** sp., CO, CT, MA, NY; **Botrytis cinerea**, CT, MA, NY.

ROT, Collar. **Fomes ribis**, KS, MT.

ROT, Root. **Helicobasidium purpureum**, TX.

RUST. **Puccinia crandallii** (0, I), CA, CO, ID, MT, ND, UT, WA, WY; II, III on grasses; **P. symphoricarpi** (III), MT to CA, AK.

SPOT ANTHRACNOSE; Scab. **Sphaceloma symphoricarpi**, ME to VA, AR, CA, CO, OR, WA, WI.

Anthracnose and spot anthracnose, scab, commonly disfigure berries.

SNOWDROP (*Galanthus*)

BLIGHT, Botrytis. **Botrytis galanthina** on imported bulbs.

SNOW-ON-THE-MOUNTAIN (*Euphorbia marginata*)

BLIGHT, Gray Mold. **Botrytis cinerea**, NJ.

LEAF SPOT. **Alternaria** sp., KS, TX; **Cercospora euphorbiicola**, NE; **C. pulcherrimae**, OK; **Phyllosticta** sp., NJ.

POWDERY MILDEW. **Microsphaera euphorbiae**, IN, IA, KS, MO.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Puccinia panici** (0, I), MS to TX, CO, SD; **Uromyces euphorbiae**, IA, SD to TX, CO.

SOAPBERRY, SOUTHERN (*Sapindus saponaria*)

BLIGHT, Thread. **Pellicularia koleroga**, FL.

LEAF SPOT; Dieback. **Glomerella cingulata**, FL; **Phyllosticta sapindii**, FL.

SOAPBERRY, WESTERN (*Sapindus drummondii*)

BLIGHT, Leaf. **Cylindrosporium griseum**, OK, TX.
LEAF SPOT; Dieback. **Glomerella cingulata**, TX; **Mycosphaerella sapindii**, MO.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, NM, TX.
POWDERY MILDEW. **Uncinula circinata**, TX.
ROT, Root. **Helicobasidium purpureum**, TX.
VIRUS. **Mosaic**, TX.
This is one of the few plants reported resistant to Texas root rot.

SOAPWORT (*Saponaria*)

LEAF SPOT. **Alternaria saponariae**, also stem spot, CT to MD, IN, MN; **Cylindrosporium officinale**, IN; **Phyllosticta tenerrima**, NJ, TX; **Septoria noctiflorae**, IL.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia aristidae** (0, I), CO.

SOCIETY GARLIC (*Tulbaghia*)

NEMATODE, Root Knot. **Meloidogyne incognita**, FL.

SOLOMONS-SEAL (*Polygonatum*)

LEAF SPOT. **Colletotrichum liliacearum**, secondary, cosmopolitan; **Sphaeropsis cruenta**, CT, IN, IA, NY, OH, VA, WI.
ROT, Rhizome. **Stromatinia smilacinae**, NY.
RUST. **Puccinia sessilis** (0 I), AL, CT, ID, IA, MN, NY, OH, PA, WI, WY; II, III on *Phalaris*; **Uromyces acuminatus** var. **magnatus** (0, I), IL, IA, MN, NE, ND, SD; II, III on *Spartina*.
SMUT, Leaf. **Urocystis colchici**, IA.
VIRUS. **Mosaic**. Unidentified, ME.

FALSE SOLOMONS SEAL (*Maianthemum racemosum*)

LEAF SPOT. **Cercosporella idahoensis**, ID; **Cylindrosporium smilacinae**, CA, CO, OR, UT; **Heterosporium asperatum**, WY; **Phloeospora vagnerae**, MT; **Ramularia smilacinae**, MT, WY, WA; **Septoria smilacinae**, general; **Sphaeropsis cruenta**, CA, NM; **Phytophthora ramorum**, CA.

ROT, Rhizome. **Stromatinia smilacinae**, NY.

RUST. **Puccinia sessilis**, CA, ID, IA, KS, ND, SD, MT, NE, NY, OK, PA, WA; **Uromyces acuminatus** var. **magnatus**, CO, IL, MN, MT, NE, ND, SD, WI; II, III on *Spartina*.

SMUT, Leaf. **Urocystis colchici**, MT.

SONCHUS

ROT. **Macrophomina phaseolina**, AZ.

VIRUS. **Sowthistle Yellow Vein**.

SOPHORA (Pagoda Tree, Silky Sophora, Mescalbean)

BLIGHT, Twig. **Nectria cinnabarina**, CT, NY.

CANKER. **Fusarium lateritium**, NJ.

DAMPING-OFF. **Rhizoctonia solani**, CT.

DIEBACK. **Diplodia sophorae**, OH.

LEAF SPOT. **Phyllosticta sophorae**, OK, TX.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.

NEMATODE, Root Knot. **Meloidogyne** sp., MD.

POWDERY MILDEW. **Microsphaera alni**, CT.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Uromyces hyalinus** (0, I, II, III), SD to TX, AZ, WY.

VIRUS. **Brooming Disease**. Unidentified.

SOWTHISTLE, ANNUAL (*Sonchos oleraceus*)

RUST. **Miyagia pseudosphaeria**, CA.

SOYBEAN (*Glycine max*)

ANTHRACNOSE. **Glomerella glycines**, IA, MI, NC to FL, NE, TX; **Colletotrichum truncatum**; **C. coccodes**, IL.

BACTERIAL Blight. **Pseudomonas syringae** pv.**glycinea**, East and South to MN, TX.

BACTERIAL, MLO. Bud Proliferation, LA.

BACTERIAL Leaf Crinkle. Unidentified, Midwest.

BACTERIAL Pustule; Pustular Spot. **Xanthomonas glycines** (**phaseoli** var. **sojense**), general.

BACTERIAL Tan Spot. **Clavibacter flaccumfaciens**, IA.

BACTERIAL Wildfire. **Pseudomonas tabaci**, MD to AL, LA, NE.

BACTERIAL Wilt. **Pseudomonas solanacearum**, NC.

BLIGHT, Aerial. **Rhizoctonia solani**, LA.

BLIGHT, Ashy Stem; Charcoal Rot. **Macrophomina phaseoli**, NJ to SC, NE, OH, TX, WA, WI.

BLIGHT, Gray Mold; Leaf Spot. **Botrytis cinerea**, CT, OH.

BLIGHT, Leaf. **Choanephora infundibulifera**, LA.

BLIGHT, Pod and Stem. **Diaporthe sojae**, NY, MI, to GA, KS, LA.

BLIGHT. **Sclerotinia minor**, **S. sclerotiorum**, VA.

BLIGHT, Southern. **Sclerotium rolfsii**, VA to FL, IA, KS, TX.

CANKER, Stem. **Diaporthe phaseolorum** vars. **batatatis, meridionalis**, and **caulivora**, AR, FL, IL, IN, KY, LA, MD, OH, SC, TX, WI; **Phyllosticta sojicola**, AR, MD, stem and pod canker.

DAMPING-OFF; Root Rot. **Pythium** spp., IL, IA, MN, MO, NC, ND; **P. aphanidermatum**; **P. torulosum**, IA; **Phytophthora megasperma** f. sp. **glycinea**, VA.

DECAY, Root, Stem. **Mycoleptodiscus terrestris**, WI.

DOWNY MILDEW. **Peronospora manshurica**, East and South to LA, IA.

LEAF SPOT. **Alternaria** sp., widespread, secondary; **Cercospora canescens**, also on pods, stems, AL, IL, MD, MS, NC, TX, WV; **C. kikuchii**, also purple stain of seed, IN, MD, NC, VA; **C. sojina**, frog-eye spot, MI to FL, IA, NY, OK, WI; **Corynespora cassiicola** (*Helminthosporium vignicola*), target spot, AL, AR, FL, GA, LA, MN, MS, NC, SC; **Helminthosporium vignae**, zonate leaf spot, NC; **Mycosphaerella cruenta**, GA, MS; **Myrothecium roridum**, secondary, LA; **Phyllosticta glycinea**, IL, MD, MO, NC, VA; **Pleosphaerulina sojicola**, ME, NJ, NY, WI.

LEAF AND STEM DISEASE. **Cercospora zebrina** (clover isolate), NC.

LEAF SPOT, Brown Spot. **Septoria glycines**, AR, DE, IN, IA, MD, NC, WI.

MOLD, White. **Sclerotinia sclerotiorum**, ME.

NEMATODE, Cyst. **Heterodera glycines**, soybean cyst, AR, IA, KS, KY, LA, MI, MN, MO, NE, NC, ND, OH, SD, TN, TX; **H. gottingiana**, pea cyst; **H. trifolii**, clover cyst; **Cactodera estonica**, WI.

NEMATODE, Dagger. **Longidorus** sp.

NEMATODE, Lesion. **Pratylenchus safaenis**, GA.

NEMATODE, Root Knot. **Meloidogyne hapla**; **M. javanica**.

NEMATODE, Spiral. **Helicotylenchus erythrinae**; **H. nannus**.

NEMATODE, Stem. **Ditylenchus dipsaci**, NY.

NEMATODE, Sting. **Belonolaimus gracilis**; **B. longicaudatus**.

NONPARASITIC. **Baldhead**. Mechanical injury.

Chlorosis. Interveinal. Manganese deficiency, AL, NC, TN.

Yellowing. Potassium deficiency, iron deficiency.

POWDERY MILDEW. **Erysiphe polygoni**, DE, IA, NC, SC; **Microsphaera diffusa**, DE, MN, NC.

ROT, Charcoal. **Macrophomina phaseolina**, IA, MN, ND.

ROT, Red Crown. **Cylindrocladium crotalariae**, Telemorph, **Calonectria crotalariae**, MS.

ROT, Root. **Corynespora cassiicola**, WI; **Phymatotrichum omnivorum**, TX; **Pythium aphanidermatum**, AZ; **P. dissotocum**, AZ; **Stachybotrys chartarum**, IL.

ROT, Root and Stem. **Phytophthora megasperma** f. sp. **glycinea**, DE, Northeast, MN, SD; **P. sojae**, AR, IL, MN, ND.

ROT, Seed. **Fusarium scirpi**, NE; **F. graminearum**, IL; **Nematospora coryli**, NC, OK, SC, VA; **Aspergillus** spp; **Phomopsis sojae**, NY.

ROT, Stem. **Cephalosporium gregatum**, brown stem, IL, IN, IA, KY, MN, MO, NC, OH, VA; **Pellicularia filamentosa**, also root rot, canker, general; **Sclerotinia sclerotiorum**, AZ, IA, MD, NY, VA; **Phytophthora megasperma** var. **sojae**; **Neocosmospora vasinfecta**, AL.

RUST. **Phakopsora pachyrhizi**, AL, AR, FL, GA, HI, IL, IN, KY, LA, MD, MS, MO, NC, SC, TN, TX; **P. packopsora**, VA, Mexico.

SUDDEN DEATH SYNDROME. **Fusarium solani** f. sp. **glycines**, AR, DE, IA, KY, MN, MO, NE, OH, PA; **Phoma** sp.; **Epicoccum** sp.; **Alternaria** sp., **Trichoderma** sp., MO.

VIRUS. **Soybean Mosaic**; **Tobacco Ring Spot**, causing bud blight, midwestern U.S.; **Beet Curly Top**; **Bean Pod Mottle**, NE; **Soybean Yellow Mosaic**, Midwest; **Cowpea Mosaic**, IL; **Tobacco Streak**, OK; **Soybean Dwarf**, CA; **Tobacco Mosaic**; **Pepper Golden Mosaic**, Mexico; **Soybean Dwarf**, WI; **Bean Pod Mottle**, AL, Ontario, Canada; **Tomato Spotted Wilt**, Tospovirus, GA; **Rhynchosia Golden Mosaic**, Mexico; **Iris Yellow Bunyaviridae**, FL, GA.

WILT. **Fusarium oxysporum** f. sp. **tracheiphilum**, PA to FL, NE, TX; also CA.

Edible soybeans are well-suited to home garden culture and usually produce a good crop without control measures beyond dusting seed with a protectant before planting. Commercial growers find a number of diseases of economic importance; bacterial pustule, the various blights, leaf spots, downy mildew, wildfire, virus diseases. Some areas are now under quarantine for the soybean cyst nematode.

SPANISH MOSS (*Tillandsia*)

BLIGHT, Stem and Leaf. **Fusarium solani**. Southeast, U.S.

SPARAXIS (*Wandflower*)

VIRUS. **Iris Mosaic**, CA, OR.

SPATHIPHYLLUM

LEAF SPOT. **Myrothecium roridum**, FL.

SPECULARIA (Venus Looking-Glass)

DODDER. **Cuscuta** sp., TX.

GALL, Leaf. **Synchytrium** sp., TX.

LEAF SPOT. **Cercospora speculariae**, LA; **Septoria speculariae**, KS, PA to AL, TX, WI.

ROT, Root. **Phymatotrichum omnivorum**, TX.

RUST. **Coleosporium campanulae** (II, III), NC, PA.

SMUT, Seed. **Ustilago speculariae**, OK.

SPHACELE (Pitcher-Sage)

RUST. **Uredo sphacelicola** (II), CA.

SPICE-BUSH (*Lindera*)

CANKER. **Botryosphaeria ribis** var. **chromogena**, MD.
LEAF SPOT. **Phyllosticta linderae**, DE, IN, WV; **P. lindericola**, WV.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), eastern states.
ROT, Root. **Phymatotrichum omnivorum**, TX.

SPIDER-LILY (*Hymenocallis*)

LEAF BLOTCH; Red Spot. **Stagonospora curtisii**, CA, TX.
LEAF SPOT. **Cercospora amaryllidis**, TX; **C. pancratii**, FL, LA, TX; **Gloeosporium hemerocallidis**, TX.
NEMATODE, Spiral. **Rotylenchus blaberus**.
VIRUS. **Mosaic**. Unidentified, CA.

SPIDERLING, WINE-FLOWER (*Boerhaavia*)

BACTERIAL Leaf Spot. **Xanthomonas campestris**, TX.
LEAF SPOT. **Ascochyta boerhaaviae**, TX; **Cercospora boerhaaviae**, TX.
NEMATODE, Root Knot. **Meloidogyne** spp.
ROT, Root. **Phymatotrichum omnivorum**, TX.
WHITE RUST. **Albugo platensis**, AZ, FL, NM, TX.

SPINACH (*Spinacea*)

ANTHRACNOSE. **Colletotrichum spinaciae**, CT, LA, MS, NJ, NY, TX, VA; **C. spinacicola** (*Gloeosporium spinaciae*); **C. dematium**, CA.
BACTERIAL Leaf Spot. **Pseudomonas syrinagae** pv. **syringae**, CA.
BACTERIAL, MLO. **Aster Yellows**.
BACTERIAL Soft Rot. **Erwinia carotovora**, general in transit, market.
BLIGHT, Phytophthora. **Phytophthora capsici**, IL.
DAMPING-OFF; Root Rot. **Rhizoctonia solani**, general; **Pythium** spp., pre-emergence seed decay.

DOWNY MILDEW. **Peronospora effusa**, general; **P. farinosa** f. sp. **spinaciae**, FL.

LEAF SPOT. **Cercospora beticola**, CA, GA, IL, IA, MA, NY, TX; **Phyllosticta chenopodii**, DE, NJ, NY, VA; **Stagonospora spinaciae**, SD; **Alternaria spinaciae**, MA; **Stemphylium botryosum**, AZ, CA, DE, MD; **Cladosporium variabile**, WA.

MOLD, Leaf. **Cladosporium macrocarpum**, secondary, DE, OK, PA, TX; **Heterosporium variabile**, pinhead "rust," general.

MOLD, Seed. **Pleospora herbarum** (*Stemphylium botryosum*); **Alternaria** sp., and secondary leaf spot; **Curvularia inaequalis**.

NEMATODE. Clover Cyst. **Heterodera trifolii**.

NEMATODE, Root Knot. **Meloidogyne** spp.

NONPARASITIC. **Yellows**. Nutrient deficiency.

ROT, Root. **Aphanomyces cladogamus**, NJ, VA; **Phymatotrichum omnivorum**, TX; **Pyrenochaeta terrestris**, IA; **Olpidium brassicae**.

ROT, Root, Crown; Wilt. **Fusarium solani**; **F. oxysporum** f. sp. **spinaciae**, general; **Phytophthora** sp., AZ, IN, NJ, NY; **P. megasperma**, CA, NC; **Sclerotinia sclerotiorum**, GA, NY.

RUST. **Puccinia aristidae** (0, I), AZ, CA, CO, OR, WA; II, III on grasses.

SMUT, Leaf. **Entyloma ellisii**, NJ, WA.

VIRUS. **Cucumber Mosaic** (Spinach Blight); **Spinach Yellow Dwarf**; **Beet Curly Top**; **Beet Ring Mottle**; **Beet Pseudo-Yellows**; **Tomato Spotted Wilt**; **Lettuce Mosaic**, NY; **Lettuce Speckles Mottle**, CA; **Spinach Latent**; **Potato Leaf Roll**, Pacific Northwest.

WHITE RUST. **Albugo occidentalis**, AR, OK, TX.

WILT. **Verticillium** sp., NY.

Downy mildew is the outstanding spinach disease, with all varieties susceptible in some degree because of physiologic races, although Dixie Market, Savoy Supreme, and others are considered resistant. To reduce blight, use virus-tolerant varieties.

SPIRAEA (Native Hardhack, Meadowsweet)

BLIGHT, Seedling; Stem Girdle. **Thelephora terrestris**, ID.

CANKER. **Cryptodiaporthe macounii**, NY.

LEAF SPOT. **Cercospora rubigo**, CA, KS, OR, WI; **Cylindrosporium** spp., ID, NY; **Phloeospora salicifoliae**, NY to KS, TX, WA.

POWDERY MILDEW. **Podosphaera oxyacanthae**, widespread; **Sphaerotheca macularis**, CT, MI, NY, PA.

SPIREA, ORIENTAL FLOWERING (*Spiraea*)

BACTERIAL Fire Blight. **Erwinia amylovora**, MD, NJ, NC, VA.
BACTERIAL Hairy Root. **Agrobacterium rhizogenes**, IA.
LEAF SPOT. **Cylindrosporium filipendulae**, IA, OR, WA, WI.
NEMATODE, Root Knot. **Meloidogyne** spp., FL, MS; **M. hapla**.
POWDERY MILDEW. **Microsphaera alni**, CT; **Podosphaera oxyacanthae**, widespread; **Sphaerotheca macularis**, TX.
ROT, Root. **Phymatotrichum omnivorum**, AZ, TX.

SPONDIAS (Mombin)

NEMATODE, Root Knot. **Meloidogyne** sp., FL.
SPOT ANTHRACNOSE; Mombin Scab. **Sphaceloma spondiadis**, FL.

SPRUCE (*Picea*)

BLIGHT, Brown Felt. **Herpotrichia nigra**, MT, Northern Rocky Mts., Pacific Northwest; **Neopeckia coulteri**.
BLIGHT, Needle. **Sirula macrospora**, ND; **Stigmina lautii**, NC.
BLIGHT, Seedling Smother. **Thelephora terrestris**, ID, MN, OH; seedling, **Rosellinia herpotrichioides**, WA.
BLIGHT, Shoot. **Sirococcus strobilinus**, KS, NC, WI; **Phomopsis occulta**, WI.
BLIGHT, Snow. **Phacidium infestans**, New England states; **Botrytis cinerea**, NJ; **Lophophacidium hyperboreum**, MN.
BLIGHT, Twig. **Ascochyta piniperda**, ME, NC.
BROOMING. **Rhizosphaera kalkhoffii**, Central Rocky Mts.
CANKER, Bark. **Aleurodiscus amorphus**, widespread.
CANKER; Twig Blight. **Cytospora kunzei** (*Valsa kunzei* var. *piceae*), New England to NJ, IL, MN.
DAMPING-OFF. **Cylindrocladium scoparium**, MI, NJ; **Phytophthora cinnamomi**, MD, NY, VA; **P. cactorum**, NY, VA; **Pythium ultimum**,

widespread; **Rhizoctonia solani**, cosmopolitan; **Aphanomyces euteiches**; **Caloscypha fulgens**, OR, WA.

DIEBACK, Branch. **Phomopsis occulta**, MI.

MISTLETOE; Witches' Broom. **Arceuthobium campylopodium**, Rocky Mts., NM, TX; **A. pusillum**, New England, especially ME, NH, to Great Lakes states, MN, WI; **A. vaginatum**, CO.

NEEDLE CAST. **Rhizosphaera kalkhoffii**, northeastern U.S., AZ, IN, MI, MN, PA, WI.

NEEDLE CAST; Tar Spot. **Lophodermium filiforme**, AK, CO, NY; **L. piceae**, New England to Great Lakes states, Pacific Northwest; **Lophodermina septata**, OR; **Rhizosphaera kalkhoffii**, CT, NY, VA; **Bifusella crepidiformis**, MT; **Cladosporium** sp., ME.

NEMATODE. **Nacobbodera chitwoodi**, OR.

NEMATODE. **Paratylenchus projectus**; **Pratylenchus penetrans**; **Tylenchus marginatus**.

NEMATODE, Dagger. **Xiphinema americanum**, WI.

ROT, Collar. **Diplodia pinea**, NJ, NY; **Sphaeropsis ellisii**, NJ.

ROT, Heart. **Fomes annosus**, CA to WA; **F. pini**, widespread; **F. pinicola**, widespread; **F. roseus**; **F. subroseus**, wide spread; **Polyporus** spp.

ROT, Root. **Armillaria mellea**, AZ, CO, NM, OR, PA, UT, WA; **Inonotus tomentosus**; **Phymatotrichum omnivorum**, TX; **Sparassis radicata**, ID, MT, OR, WA; **Phytophthora cinnamomi**, NC; **P. dreschleri**, NC; **P. cryptogea**, NC; **Fusarium solani**, PA; **F. oxysporum**, PA; **F. avenaceum**, PA; **Cylindrocladium canadense**, Montreal, Canada.

ROT, Root, Butt. **Hyphodontia aspera**, NH.

RUST, Cone. **Chrysomyxa pirolata** (0, I), AK, CO, ME, MA, MI, MT, NH, NY, OR, PA, VT; II, III on *Moneses* and *Pyrola*.

RUST, Needle. **Chrysomyxa empetri** (0, I), ME; **C. ledi** (0, I), New England to Great Lakes; II, III on *Ledum*; **C. ledi** var. **cassandrae** (0, I), New England to Great Lakes; II, III on *Chamaedaphne*; **C. ledicola** (0, I), northern U.S. from ME toWA, AK, CO; II, III on *Ledum*; wild rosemary; **C. piperiana** (0, I), CA, OR; II, III on *Rhododendron californicum*, **C. roanensis** (0, I), NC, TN; II, III on *Rhododendron catawbiense*, **C. weirii**, TN, WV to VT, WI, SD to WA, most Canadian Provinces; **C. arctostaphyli** (0, I); III on bearberry.

RUST; Witches' Broom. **Melampsorella cerastii**, widespread.

Cytospora canker frequently kills lower branches of ornamental spruces. There is little control except to remove affected portions.

SPURGE CAPER (*Euphorbia lathyris*)

ROT, Root. **Macrophomina phaseolina**, AZ, **Rhizoctonia solani**, AZ; **Pythium aphanidermatum**, AZ.

SPURGE, CYPRESS (*Euphorbia cyparissias*)

ANTHRACNOSE. **Sphaceloma poinsettiae**, FL.
LEAF SPOT. **Cercospora euphorbiae**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia** sp.
RUST. **Melampsora euphorbiae** (0, I, II, III), ME to PA, IN, WI.

SPURGE, FLOWERING (*Euphorbia corollata*)

LEAF SPOT. **Cercospora euphorbiae**, KS, TX; **C. heterospora**, WI; **Phyllosticta** sp.
MOLD, Leaf. **Cercosporidium fasciculatum**, IA.
POWDERY MILDEW. **Microsphaera euphorbiae**, MD to GA, IN, WI.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia panici** (0, I), OH to AL, MN, TX; II, III on *Panicum*.

SPURGE LEAFY (*Euphorbia esula*)

LEAF SPOT; Blight. **Alternaria angustiovoidea**.
ROT, Crown and Root. **Fusarium oxysporum**; **F. solani**; **F. proliferatum**, MT.

SPURGE, PAINTED (*Euphorbia heterophylla*)

CANKER, Stem. **Diaporthe phaseolarum** var. **caulivora**, LA; pathogen of soybean stem canker.
RUST. **Uromyces euphorbiae** (0, I, II, III), IN to FL, KS, TX.
SMUT, Stem. **Tilletia euphorbiae**, LA.
VIRUS. **Euphorbia Mosaic**, FL.

SPURGE, PROSTRATE (*Euphorbia supina*)

CANKER, Girdling Stem; Gray Mold. **Amphobotrys ricini**, FL, LA, MD, MS, OK, TX.

SPURGE, SPOTTED (*Euphorbia maculata*)

NEMATODE, Root Knot. **Meloidogyne hapla**.

SQUASH and PUMPKIN (*Cucurbita*)

ANTHRACNOSE. **Colletotrichum lagenarium**, CT to NJ, KS, TX.

BACTERIAL, MLO. **Aster Yellows**.

BACTERIAL Soft Rot. **Erwinia carotovora** pv. **carotovora**, cosmopolitan; **E. aroideae**.

BACTERIAL Spot. **Xanthomonas cucurbitae**, CT, GA, IL, IN, MD, MA, MI, WA, WI; **Pseudomonas syringae** pv. **lachrymans**; **P. syringae** pv. **syringae**, GA.

BLIGHT, Blossom. **Choanephora cucurbitarum**, brown rot of fruit, ME to FL, MI, OK, TX.

BLIGHT, Gummy Stem; Black Rot of Fruit. **Mycosphaerella citrullina** (*M. melonis*), CT, FL, GA, MA, MI, NJ, NY.

BLIGHT, Leaf. **Alternaria cucumerina**, DE, MN, NJ, NY, NC, UT; **Phytophthora capsici**, also stem rot, fruit rot, AR, CA, IL, NM, NC.

BLIGHT, Southern. **Sclerotium rolfsii**, AL, FL, GA.

BLIGHT, Stem. **Fusarium tabacinum** (*Plectosporium tabecinum*), AL, IL, NY, TN.

DAMPING-OFF. **Pythium debaryanum**, CT, WI.

DOWNY MILDEW. **Pseudoperonospora cubensis**, ME to AL, CA, IA, LA, TX.

LEAF SPOT. **Ascochyta** sp.; **Cercospora cucurbitae**, AL, DE, NJ, WI; **C. citrullina**, AL; **Gloeosporium** sp., IL; **Phyllosticta cucurbitarum**, IN, NY; **P. orbicularis**, DE, PA, NY; **Septoria cucurbitacearum**, IL, MA, NY, WI; **Stemphylium cucurbitacearum**, IN, OH.

MOLD, Seed. **Alternaria tenuis**, cosmopolitan; **A. radicina**, occasional; **Curvularia trifolii**, CT.

NEMATODE, Root Knot. **Meloidogyne** spp., MD to FL, TX.

NEMATODE, Stubby Root. **Trichodorus christiei**.

NONPARASITIC. **Blossom-End Rot**. On summer squash when hot, dry weather follows a cool, rainy spell.

Chlorosis. Nutrient deficiency: manganese, interveinal chlorosis, nitrogen, leaf yellowing and chlorosis of bud end of fruit.

Bronzing. Marginal Necrosis; Fruit Deformity. Potassium deficiency.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Sphaerotheca fuliginea**, CA, IN, MI, NY, NC.

ROT, Blossom-end; Root, **Pythium aphanidermatum**, AZ, CA, MD.

ROT, Charcoal. **Macrophomina phaseolina**, OR, TX.

ROT, Fruit. **Acidiovorax avenae** (syn. **Pseudomonas pseudoalcaligenes**) subsp. **citrulli**, GA; **Alternaria** sp., MA, NH, NJ, NY, OR, VT, WA; **Diplodia natalensis**, TX; **Coniosporium fairmani**, black mold; **Botrytis cinerea**, gray mold; **Fusarium** spp.; **F. solani** f. sp. **cucurbitae**, also root and stem rot, CA, CT, NY, OR, WA; **F. equiseti**, AR, CT; **F. acuminatum**, CT; **F. graminearum**, CT; **F. avenaceum**, CT; **Phytophthora cactorum**, AZ; **P. nicotianae**, NC; **Pythium ultimum**, CA; **Rhizopus stolonifer**, general in storage after injury; **Sclerotinia sclerotiorum**, ID, MA, ME, NH, NY, WA; **Trichothecium roseum**, pink mold, MA; **Phoma subvelata**, also leaf spot, stem rot, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, TX.

SCAB; Leaf Spot; Storage Rot. **Cladosporium cucumerinum**, CT, MD, MA, NJ, NY, OR, WA.

VIRUS. **Bromegrass Mosaic**. General, IA, SD on squash (*Cucurbita pepa*); **Lettuce Mosaic**, NY; **Squash Mosaic**, CA, SD; **Southern Squash Mosaic**; **Cucumber Mosaic**; **Beet Curly Top**; **Tobacco Ring Spot**; **Prunus Ring Spot**; **Watermelon Mosaic**; **Zucchini Yellow Mosaic**, AR, CA, CT, FL, LA, NJ, NY, OH, SC; **Squash Leaf Curl**, CA; **Lettuce Infectious Yellows**, AZ, CA, TX; **Cucurbit Leaf Curl**, AZ, TX, Mexico; **Beet Pseudo Yellows**, CA; **Potato Leaf Roll**, Pacific Northwest.

WILT. **Fusarium oxysporum** f. sp. **niveum**, CA, IL, MI, WI; **Verticillium albo-atrum**, OR.

WILT, Anasa. Feeding injury from the squash bug.

In general, diseases and control measures are the same as for cucumbers. Some squash varieties are injured by sulfur dusts. Acorn and butternut squashes are resistant to bacterial wilt.

SQUASH-BUSH (*Condalia*)

MISTLETOE. **Phoradendron californicum**, CA.

SQUAW-APPLE (*Peraphyllum*)

LEAF SPOT. **Septoria peraphylli**, UT.

RUST. **Gymnosporangium inconspicuum** (0, I), CO; III on juniper; **G. nelsonii** (0, I), on leaves, fruit; CO, UT.

STACHYS (Betony, Hedgenettle, Woundwort)

GALL, Leaf. **Synchytrium stachydis**, LA.

LEAF SPOT. **Cercospora stachydis**, IA, ME; **Cylindrosporium stachydis**, IL; **Ovularia bullata**, CA; **Phyllosticta decidua**, MA, WI; **P. palustris**, IL, OH; **Ramularia stachydis**, OR; **Septoria stachydis**, CA, IL, MS, NY, WI.

NEMATODE, Root Knot. **Meloidogyne** sp.

POWDERY MILDEW. **Erysiphe galeopsidis** (*Golovinomyces cichoracearum*), OH to CO, MT, NY to IN, WI; **Sphaerotheca macularis**, CA.

RUST. **Puccinia pallidissima**, TX.

VIRUS. **Tomato Spotted Wilt**, GA.

STAPHYLEA (Bladdernut)

BLIGHT, Twig. **Hypomyces ipomoeae**, MA; **Coryneum microstictum**, MA.

LEAF SPOT. **Mycosphaerella staphylina**, GA, KS. **Ovularia isarioides**, NY to MO, IA; **Septoria cirrhosa**, MO.

STARBUR, BRISTLY (*Acanthospermum*)

VIRUS. **Tomato Spotted Wilt**, GA.

STARFLOWER (*Trientalis*)

GALL, Leaf. **Synchytrium aureum**, PA.

LEAF SPOT. **Cylindrosporium magnusianum**, CA, MA, MI, NY, WI; **Septoria increscens**, CA, ME, MI, NY, VT, WI; **Phytophthora ramorum**, CA.
ROT, Leaf. **Ceratobasidium anceps**, WI.
RUST. **Puccinia caricina** var. **limosae** (0, I), AK, NY, WI; II, III on *Carex*.
SMUT, Leaf and Stem. **Tuburcinia trientalis**, OR, WA.

STARGRASS (*Aletris*)

LEAF SPOT. **Gloeosporium aletridis**, MS.
RUST. **Puccinia aletridis** (II, III), DE, FL, IL, IN, MA, MS, NJ, NC, RI, SC, TN, WI; 0, I unknown.

STARGRASS, GOLDEN (*Hypoxis*)

LEAF SPOT. **Cylindrosporium guttatum**, WI; **Septoria hypoxis**, PA.
RUST. **Uromyces affinis** (I, III), CT, MS, MO; **U. necopinus**, NY
SMUT, Flower. **Urocystis hypoxis**, CT, MA.

STAR-OF-BETHLEHEM (*Ornithogalum*)

BLIGHT, Southern. **Sclerotium rolfsii**, CA.
LEAF SPOT. **Didymellina ornithogali**, IL, PA, WA; **Septoria ornithogali**, CT, MA.
VIRUS. **Ornithogalum Mosaic**, AL, OK, OR.

STATICE, SEA-LAVENDER (*Limonium*)

ANTHRACNOSE; Rot, Crown. **Colletotrichum gloeosporioides**, FL.
BACTERIAL, Crown and Leaf Rot. **Pseudomonas caryophylli**, FL.
BACTERIAL, MLO. **California Aster Yellows**, CA.
BACTERIAL Spot. **Pseudomonas andropogonis**, KS.

BACTERIAL, MLO. **Yellows** and **Phyllody**, MI.
BLIGHT, Flower. **Botrytis cinerea**, FL.
DOWNY Mildew. **Peronospora statices**, CA.
LEAF SPOT. **Alternaria** sp., CT; **Cercospora** sp., TX; **C. insulana**, FL; **Ascochyta plumbaginicola**, IA; **Fusicladium staticis**, TX; **Phyllosticta** sp., CT; **P. staticis**, NY.
NEMATODE, Root Knot. **Meloidogyne** sp.
ROT, Crown. **Sclerotium rolfsii**, FL; **Rhizoctonia solani**, FL.
RUST. **Uromyces limonii** (0, I, II, III), ME to MS CA, NM, TX.
VIRUS. **Turnip Mosaic**, CA.

STENANTHIUM

RUST. **Puccinia atropuncta** (II, III), GA; **P. grumosa**, OR.

STENOLOBIUM (Florida Yellow-Trumpet)

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Prospodium appendiculatum** (0, I, II, III), FL, TX.

STEPHANOMERIA (Wire-Lettuce)

LEAF SPOT. **Cercospora clavicarpa**, CA.
RUST. **Puccinia harknessii** (0, I, III), MT to NM, CA, WA.

STEPHANOTIS

ANTHRACNOSE. **Gloeosporium** sp., WA.
BLIGHT, Flower. **Botrytis elliptica**, CA.
VIRUS. **Tomato Spotted Wilt**, OR.

STERNBERGIA (Fall-Daffodil)

LEAF SCORCH; Red Spot. **Stagonospora curtisii**, CA.

STEVIA (*Piqueria*)

BACTERIAL Fasciation. **Clavibacter fascians**, MI.
BACTERIAL, MLO. **Aster Yellows**, MI, NJ.
DAMPING-OFF. **Rhizoctonia solani**, IL.
NEMATODE, Lesion. **Pratylenchus pratensis**, NJ.
POWDERY MILDEW. **Golovinomyces cichoracearum**, IL.
ROT, Stem. **Sclerotium rolfsii**, NJ.
WILT. **Verticillium dahliae**, CA.

STILLINGIA (Queens Delight)

DODDER. **Cuscuta** sp., OK.
LEAF SPOT. **Cercospora stillingiae**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Uromyces graminicola** (0, I), OK; II, III on *Panicum*.

STOCK (*Matthiola*)

ANTHRACNOSE; Leaf and Stem Spot. **Colletotrichum gloeosporioides**, TX.
BACTERIAL Black Rot. **Xanthomonas incanae**, CA, TN.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, TX.
CLUB ROOT. **Plasmodiophora brassicae**, NJ.
DAMPING-OFF. **Pythium** spp.; **Rhizoctonia solani**, cosmopolitan.
DOWNY MILDEW. **Peronospora parasitica**, CA, IL.
LEAF SPOT. **Alternaria raphani**, CA; **Myrothecium roridum**, TX.
NEMATODE. **Naccobus batatiformis**.
NEMATODE, Root Knot. **Meloidogyne** sp., TX.
ROT, Crown; Wilt. **Sclerotinia sclerotiorum**, CA, MI, PA.
ROT, Root. **Fusarium avenaceum**, DE, NJ; **Phymatotrichum omnivorum**, TX; **Phytophthora megasperma**, CA; **P. cryptogea**, stem rot, CA.
VIRUS. **Turnip Mosaic**; **Cauliflower Mosaic**; **Beet Curly Top**, CA; **Tomato Spotted Wilt**, TX.
WILT. **Fusarium oxysporum** f. sp. **mathioli**, AZ, CA; **Verticillium albo-atrum**, CA, NY.

Mosaic causes flower-breaking as well as mottling of foliage. Verticillium wilt is prevalent in cut-flower producing areas of California.

STOKESIA (Stokes-Aster)

BLIGHT, Head. **Botrytis cinerea**, NY.
LEAF SPOT. **Ascochyta** sp., IA, PA.
POWDERY MILDEW. **Golovinomyces cichoracearum**, MD.
VIRUS. **Mosaic**. Unidentified, IA; **Bidens Mottle**, FL.

STONE PLANT (*Lithops*)

ROT. **Fusarium oxysporum**, ID.

STRANVAESIA

BACTERIAL Fire Blight. **Erwinia amylovora**, NJ.
ROT, Root. **Clitocybe tabescens**, FL.

STRAWBERRY (*Fragaria*)

ANTHRACNOSE; Crown Rot. **Colletotrichum acutatum**, CT; **C. fragariae**, FL, LA; **Gloeosporium** sp., MD.
ANTHRACNOSE, Fruit. **Colletotrichum gloeosporioides**, FL, OH; **C. acutatum**, NY.
BACTERIAL Angular Leaf Spot. **Xanthomonas fragariae**, FL, KY, MN, WI.
BACTERIAL Blossom Blight. **Xanthomonas campestris** var. **fragariae**, CA.
BACTERIAL, Phytoplasma. **Aster Yellows**, strawberry green petal; **Lethal Disease Decline** or **Peach Western X Disease**. WA, OR; **Clover Proliferation**, CA, FL, MD; **Clover Yellow Edge** and **STRAWB2**, MD.
BACTERIAL Soft Rot. **Erwinia carotovora**, MA.
BLIGHT, Blossom. **Cladosporium cladosporioides**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, general on fruit.
BLIGHT, Leaf. **Dendrophoma obscurans**, angular leaf spot, MA, to FL, MI, MN, NE, OR, TX; **Phomopsis obscurans**, CT.
BLIGHT, Southern. **Sclerotium rolfsii**, AL, FL, NC, TX.
BROOMRAPE. **Orobanche** sp., WA.
DOWNY MILDEW. **Peronospora fragariae**, IA.

GALL, Leaf. **Synchytrium aureum**, on native spp., WI; **S. fragariae**, root gall, CA, WA.

LEAF BLOTCH. **Gnomonia fructicola**, also fruit rot; **G. comari**, CA.

LEAF SCORCH. **Diplocarpon earliana**, general.

LEAF SPOT. **Cercospora fragariae**, LA; **C. vexans**, CA, NY, WI; **Gloeosporium** sp., IL, MA, MI, NC, PA, UT, associated with black root; **Mycosphaerella fragariae**, common leaf spot, black-seed disease, general; **M. louisianae**, purple leaf spot, LA, MS, NC.

NEMATODE, Spring Dwarf. **Aphelenchoides fragariae**, MA to FL, AR, CA, MI, TX, TN, WA; Summer Dwarf, Crimp. **A. besseyi**, southeastern and Gulf states, also AR, CA, DE, IL, TX.

NEMATODE, Dagger. **Xiphinema americanum**; **X. diversicaudatum**; **X. chambersi**.

NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CA, ID, NC, OR, TX, WA.

NEMATODE, Lesion. **Pratylenchus penetrans**; **P. coffeae**; **P. pratensis**; **P. scribneri**.

NEMATODE, Root Knot. **Meloidogyne hapla**.

NEMATODE, Sting. **Belonolaimus gracilis**.

NEMATODE, Stubby Root. **Trichodorus christiei**.

NONPARASITIC. **Black Root**, **Brown Root**. Winter injury, defective drainage, soil toxins, widespread.

Chlorosis. Iron deficiency.

Variegation, June Yellows. Chlorophyll deficiency, especially in Blakemore, Progressive, and related varieties, general.

POWDERY MILDEW. **Sphaerotheca macularis**, general but rare in South, reported in FL, CA.

ROT, Crown. **Phytophthora cactorum**, NY; **Sclerotinia sclerotiorum**, MD to FL, CA, IL, IA, MN, TX; **Sclerotium rolfsii**, AL, FL, NC, TX; **Macrophomina phaseolina**, FL.

ROT, Fruit. **Penicillium** spp., secondary; **Pezizella lythri**, also leaf spot, root rot, ME to FL, AK, IL, IA, MI, OH, OK, OR, WI; **Phytophthora cactorum**, leather rot, AL, AR, IL, KY, LA, MD, MI, MO, OH, TN, VA; **Rhizopus nigricans**, black rot, cosmopolitan; **Rhizoctonia solani**, hard brown rot, widespread; **Sphaeropsis** sp., CA, CO, IL, IA, MN.

ROT, Red Stele; Brown Core Root Rot. **Phytophthora fragariae**, ME to VA, IA, OK; also CO, MI, WI, Pacific states.

ROT, Root. **Armillaria mellea**, CA, OR, WA; **Cylindrocladium scoparium**, OR, TN; associated with black root; **Leptosphaeria coniothyrium**; **Fusarium** spp.; **Olpidium brassicae**, WA; **Pythium** spp., widespread; **Ramularia** spp., ID, OR, WA; **Idriella lunata**, CA, MD; **Phomopsis obscurans**, OH.

ROT, Root, Stolon and Petiole. **Pestalotia longisetula**, IL, OR.

SLIME MOLD. **Diachea leucopodia**, CA, IL, KS, LA, MS, MO, TN, TX; **Fuligo septica**, IA, KS, MN, NE, NJ, TX, WA; **Mucilago spongiosa**, KS, MN, MO, NE, OK; **Physarum cinereum**, IL, NE, NJ.

SOOTY MOLD. **Scoria spongiosa**, ME.

VIRUS. **Strawberry Crinkle**, CA, ID, MN, NY, OR, WA; **Strawberry Yellow Edge**, Xanthosis, CA, NC, OR, WA, and other states introduced from West Coast; **Strawberry Leaf Roll**, MD, NJ, NY, OR, VT; **Strawberry Mottle**; **Strawberry Multiplier Disease**, WI; **Strawberry Necrotic Shock**, CA; **Strawberry Pallidosis**, CA, OR, Mid-Atlantic, British Columbia, Canada; **Strawberry Pseudo Mild Yellow Edge**; **Strawberry Mild Yellow Edge**, CA; **Strawberry Vein Necrosis**, MN; **Strawberry Vein Banding**; **Strawberry Witches' Broom**, ID, MN, MT, NY, OR, WA; **Tomato Ringspot**, PA; **Apple Mosaic**, OR; **Chlorotic Peacock Pattern**, OR; **Cucurbit Yellows**, OR; **Strawberry Phyllody**, MD, WV; **Tobacco Streak**, MD.

WILT. **Verticillium albo-atrum**, CA, FL, NY, OR, WA; **Colletotrichum acutatus**, AR, CA, FL, MS, MO.

Red Stele is, except in the deep South, of first importance on strawberries. The roots rot, and above-ground parts are stunted and wilted. Choose resistant varieties, such as Stelemaster, Sparkle, Surecrop, Midway, and Fairland. Purchase plants certified free from nematodes and virus diseases. Mulching helps to prevent fruit rots.

U.S. Department of Agriculture Farmers' Bulletin 1891 gives an excellent discussion of "Diseases of Strawberries". The American Phytopathological Society, St. Paul, MN has published a Compendium of Strawberry Diseases.

STRAWBERRY-TREE (*Arbutus unedo*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CA.

LEAF SPOT. **Septoria unedonis**, OR.

SPOT ANTHRACNOSE. **Elsinoë mattirolianum**, CA.

STRAWFLOWER (*Helichrysum*)

BACTERIAL, MLO. **Aster Yellows**, eastern and central states; **California Aster Yellows**, CA.
DOWNY MILDEW. **Plasmopara halstedii**, CA.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
ROT, Stem. **Fusarium** sp., FL.
VIRUS. **Beet Curly Top**, CA, OR, WA; **Bidens Mottle**, FL; **Tomato Spotted Wilt**, PA.
WILT. **Verticillium albo-atrum**, CA.

STREPTANTHERA

VIRUS. **Iris Mosaic**, CA, OR.

STREPTOCARPUS

VIRUS. **Tobacco Mosaic**, CA, CT, DC, FL, OH, WA; **Tomato Spotted Wilt**, PA.

STREPTOPUS (Twisted-Stalk)

LEAF SPOT. **Cercospora streptopi**, WA; **Septoria streptopidis**, MT.
RUST. **Puccinia sessilis** (0, I), NY.
SMUT, Leaf. **Tuburcinia clintoniae**, WI.
VIRUS. **Mosaic**, AK.

STROPHOSTYLES (Wild Bean)

VIRUS. **Alfalfa Mosaic**, AR; **Chlorotic Mottle**, AR; **Cowpea Chlorotic Mottle**, AR; **Quail Pea Mosaic**, AR; **Soybean Mosaic**, AR.

STYRAX (Snowbell)

LEAF SPOT. **Mycosphaerella punctiformis**, GA.
NEMATODE, Root Knot. **Meloidogyne** sp., MD.

STYLOSANTHES

LEAF SPOT, Canker. **Colletotrichum dematium** f. sp. **truncata**, FL.

SUGAR BEET (*Beta vulgaris*)

Fusarium Yellows; **Fusarium oxysporum**, MI.

SUMAC (*Rhus*)

CANKER, Stem; DIEBECK. **Botryosphaeria ribis**, "umbrella disease," NY to GA, MN, NE; **Cryptodiaporthe aculeans**, ME to AL, IA, OK; **Nectria cinnabarina**, NY, OK; **N. galligena**, NY, PA, VA; **Physalospora obtusa**, canker, inflorescence blight, NY to AL, KS, MI.

DODDER. **Cuscuta exaltata**, TX.

LEAF BLISTER. **Taphrina purpurascens**, MA to GA, KS, TX.

LEAF SPOT. **Cercospora rhoina**, general; **Pezizella oenotherae**, NY to GA, WV; **Coniothyrium rhois**, TX; **Harknessia rhoina**, CA; **Phyllosticta rhoiseda**, CA; **Septoria rhoina**, general; **Cylindrosporium** sp., CO, NE.

MOLD, Leaf. **Cladosporium aromaticum**, IA, NE, NY, WI, WV.

PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, LA, Southern U.S.

POWDERY MILDEW. **Sphaerotheca macularis**, widespread; **Oidium** sp., WI.

ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, FL; **Corticium galactinum**, white root, VA; **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Polyporus** spp.; **Poria punctata**, MI; **Schizophyllum commune**, cosmopolitan; **Steccherinum ochraceum**, PA.

RUST. **Pileolaria effusa** (0, III), AZ; **P. patzcuarensis** (0, I, II, III), CO, NM, OK.

WILT. **Fusarium oxysporum** f. sp. **rhois**, CT, KS, VA; **Verticillium albo-atrum**, IL, IA, MA, MN.

SUNFLOWER (*Helianthus*)

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **helianthi**; **P. syringae** pv. **tagetis**, WI.

BACTERIAL, MLO. **California Aster Yellows**, CA.

BACTERIAL Stem Rot. **Erwinia carotovora**, ND.

BACTERIAL Wilt and Apical Chlorosis. **Pseudomonas solanacearum**, FL; **P. syringae** pv. **tagetis**, KS, MN, ND, WI; **Erwinia carotovora** pv. **carotovora**, IN.

BLACK KNOT, Black Patch. **Gibberidea heliopsidis**, GA, IL, MS, MO, NC, VA.

BLIGHT, Gray Mold; Bud Rot. **Botrytis cinerea**, CA, OR.

BLIGHT, Petal. **Itersonilia perplexans**, FL.

BLIGHT, Seedling. **Alternaria helianthi**, MN; **Diaporthe helianthi**, TX.

BLIGHT, Southern, **Sclerotium rolfsii**, LA, TX.

CANKER, Stem. **Diaporthe helianthi**, OH, TX.

DODDER. **Cuscuta** sp., OK, TX, WA.

DOWNY MILDEW. **Plasmopara halstedii**, NY to MD, KS, MT, TX.

GALL, Basal. **Plasmopara halstedii**, MN, ND.

LEAF SPOT. **Ascochyta compositarum**, WI; **Cercospora helianthi**, IL, KS, MO, OH, TX. WI; **C. pachypus**, AL, KS, OK, TX; **Colletotrichum helianthi**, WI; **Septoria helianthi**, general; **Alternaria zinniae**; **Alternaria helianthi**, MN, OH.

NEMATODE, Leaf Gall. **Tylenchus balsamophilus**, WA.

NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL, TX, WV.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general, CA.

ROT, Charcoal. **Macrophomina phaseoli**, CA, MD; **M. phaseolina**, ND, SD.

ROT, Head. **Rhizopus oryzae**, CA; **Phoma macdonaldii**, premature ripening, ND.

ROT, Root. **Armillaria mellea**, OR; **Helicobasidium purpureum**, violet root, TX; **Phymatotrichum omnivorum**, TX; **Pythium debaryanum**; **Rhizoctonia solani**, IL, MD, NE, NY, WI.

ROT, Stem. **Phytophthora cryptogea**, CA; **Septosphaeria lindquistii**, black stem, MN, ND.

ROT, Stem. **Sclerotinia sclerotiorum**, widespread.

RUST. **Coleosporium madiae**, CA.

RUST. **Puccinia helianthi**, (0, I, II, III), general, CA; **P. massalis**, NM, TX; **P. canaliculata**, GA, KS; **P. xanthii**, ND; **Coleosporium helianthi** (II, III), NY to FL, LA and OK; II, III on pine; **Uromyces junci** (0, I), CA, KS, NE, ND, OK, SD, WY; **U. silphii** (0, I), IL, MO, NY, TN, WI.

SMUT, Leaf. **Entyloma polysporum** CA, MT.

VIRUS. **Bromegrass Mosaic** General, IA, SD; **Sunflower Mosaic**, IN, TX; **Cucumber Mosaic**, FL, MD; **Bidens Mottle**, FL.
WHITE RUST. **Albugo tragopogonis**, CO, IL, KS, MO, WI.
WILT. **Fusarium oxysporum** f. sp. **apii**, SC; **Verticillium albo-atrum**.
WILT. **Sclerotinia sclerotiorum = Whetzelinia sclerotiorum**, CA.
WILT. **Verticillium dahliae**, CA.

SUNROSE (*Helianthemum*)

LEAF SPOT. **Cylindrosporium eminens**, TX, WI; **Septoria chamaecisti**, WA.
ROT, Root. **Phymatotrichum omnivorum**, TX.

SWEDISH IVY (*Plectranthus australis*)

NONPARASITIC. **Brown Leaf Spot**. Boron deficiency.
VIRUS. **Alfalfa Mosaic**, NY; **Tomato Spotted Wilt**, PA; and **TSW-Impatiens Serotype**, GA, FL.

SWEET ALYSSUM (*Lobularia*)

BACTERIAL, MLO. **Aster Yellows**, NJ.
CLUB ROOT. **Plasmodiophora brassicae**, NJ.
DAMPING-OFF, Root Rot. **Rhizoctonia solani**, NJ, NY, VA; **Pythium ultimum**, NJ.
DODDER. **Cuscuta** sp., TX.
DOWNY MILDEW. **Peronospora parasitica**, CA, NJ.
NEMATODE, Root Knot. **Meloidogyne** sp.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Crown. **Sclerotinia sclerotiorum**, VA.
ROT, Root. **Phoma lingam**, CA.

SWEET-FERN (*Comptonia*)

RUST, Blister. **Cronartium comptoniae** (II, III), ME to MN, NC, OH; 0, I on hard pine.
RUST, Leaf. **Gymnosporangium ellisii** (0, I), NJ; II, III on *Chamaecyparis*.

SWEET-FLAG (*Acorus*)

LEAF SPOT. **Cylindrosporium acori**, CT, KS; **Ramularia aromatica**, CT to MD, IN, WI; **Septocylindrium** sp., NY.

RUST. **Uromyces sparganii** (II, III), ME to VA, IL, MN, MS; 0, I unknown.

SWEET GALE (*Myrica gale*)

BLIGHT, Twig. **Diplodia** sp., NJ.

LEAF SPOT. **Ramularia monilioides**, NY: **Septoria myricata**, NY.

RUST. **Cronartium comptoniae**, ME to NY, WA; 0, I on pine; **Gymnosporangium ellisii** (0, I), ME.

SWEET GUM (*Liquidambar*)

ANTHRACNOSE. **Gloeosporium nervisequum**.

BACTERIAL LEAF SCORCH. **Xylella fastidiosa**, KY.

BLIGHT; Leader Dieback. Cause unknown, killing trees in AL, AR, FL, GA, LA, MD, SC, TX.

BLIGHT, Thread. **Pellicularia koleroga**, LA.

CANKER; DIEBACK. **Botryosphaeria ribis** var. **chromogena**, IL, NY, MD to FL, LA; **B. dothidea**, MS; **Hymenochaete agglutinans**, MD; **Nectria** sp.; **Dothiorella berengeriana**, bleeding necrosis, NJ, NY.

CANKER, Felt Fungus. **Septobasidium alni**; **S. apiculatum**, **S. burtii**, **S. mariani**, **S. pseudopedicellatum**, and **S. sinuosum**, southern states.

LEAF SPOT. **Cercospora liquidambaris**, MD to FL, TX; **C. tuberculans**, FL, LA, MS, MO; **Discosia artocreas**, OK; **Exosporium liquidambaris**, TX; **Leptothyrella liquidambaris**, red leaf spot, IL, MD, NC; **Septoria liquidambaris**, MA to FL, TX; **Actinopelte dryina**; **Cladosporium** sp., OR.

MISTELTOE. **Phoradendron serotinum** (**flavescens**), OH to NC, TX.

NEMATODE, Root Knot. **Meloidogyne** sp.

NONPARASITIC. **Blight**; **Decline**; Leader Dieback. Killing trees in AL, AR, FL, GA, LA, MD, SC, TX. Partly moisture shortage.

ROT, Heart. **Polyporus adustus** and **P. gilvus**, widespread.

ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.

ROT, Root. **Cylindrocladium scoparium**, GA.

ROT, Wood. **Daedalea confragosa**, cosmopolitan; **Fomes** spp., **Ganoderma** spp.; **Hericium erinaceus**; **Steccherinum ochraceum**; **S. pulcherrimum**, Gulf states; **Polyporus** spp., **Poria** spp.; **Pleurotus** spp.; **Schizophyllum commune**, cosmopolitan; **Stereum** spp.

SWEETLEAF (*Symplocos*)

GALL, Bud. **Exobasidium symploci**, Gulf states to NC and IN.
LEAF SPOT. **Septoria stigma**, AL; **S. symploci**, FL, MS, NC, OK, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

SWEET-OLIVE (*Osmanthus fragrans*)

BLACK MILDEW; Black Spot. **Asterina** sp., MS.
LEAF SPOT. **Gloeosporium oleae**, MD.
ROT, Root. **Armillaria mellea**, CA; **Clitocybe tabescens**, LA.

SWEET PEA and PERENNIAL PEA (*Lathyrus*)

ANTHRACNOSE; Blossom and Shoot Blight. **Glomerella cingulata**, general except on Pacific Coast.
BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, NJ, VA.
BACTERIAL Fasciation. **Clavibacter fascians**, widespread.
BACTERIAL Leaf Spot. **Pseudomonas pisi**, IN, WI.
BLIGHT, Gray Mold. **Botrytis cinerea**, general.
BLIGHT, Southern. **Sclerotium rolfsii**, FL, TX.
DAMPING-OFF; Root and Stem Rot. **Pythium** spp., CA, CT, MD, MA, NJ, NY, NC; **Rhizoctonia solani**, general.
DODDER. **Cuscuta indecora**, TX.
DOWNY MILDEW. **Peronospora trifoliorum**, FL.
LEAF SPOT. **Alternaria** sp., secondary, MD, MA, NJ, NY, PA, TX; **Colletotrichum pisi**, AL, FL, GA, SC; **Ascochyta** sp., also stem spot, CT, LA, MN, MO, WV, WI; **A. lathyri**, NJ; **Cercospora lathyrina**, GA, OK; **Isariopsis griseola**, CT; **Mycosphaerella pinodes**, also stem spot, MN, WI; **Ovularia** sp., CA; **Phyllosticta orobella**, TX; **Ramularia** sp.,

NY, MA, NJ, PA, TX, WA; **R. deusta** f. sp. **odorati**, CA; **Curvularia** sp., CA.

MOLD, White. **Erostrotheca multiformis** (*Cladosporium album*) CA, MA, NJ, NY, PA, TX, WA, in greenhouses.

NEMATODE, Lesion. **Pratylenchus pratensis**, NJ, NY.

NEMATODE, Root Knot. **Meloidogyne** spp., FL, MA, NJ, NY, TX.

NONPARASITIC. **Bud Drop**. Unbalanced nutrition, low light intensity in greenhouses.

POWDERY MILDEW. **Microsphaera alni**, general, especially in greenhouses; **Erysiphe polygoni**, widely reported, sometimes confused with *M. alni*.

ROT, Root. **Aphanomyces euteiches**, IN, MI, WI; **Fusarium solani** f. sp. **pisi**, occasional to prevalent under glass and outdoors; **Phymatotrichum omnivorum**, TX, **Phytophthora cactorum**, CT; **Thielaviopsis basicola**, black rot, CT to OH, CO, FL, IL, MS; Pacific Coast.

ROT; Stem Wilt. **Sclerotinia sclerotiorum**, MD, PA.

VIRUS. **Pea Mosaic**; **Tomato Spotted Wilt**; **Sweet Pea Streak**. A complex, components not identified, perhaps in part bacterial.

WILT. **Verticillium** sp., NY, NJ; **Fusarium oxysporum** f. sp. **vasinfectum**, FL, NY.

Control aphids and thrips spreading mosaic and spotted wilt.

SWEETPOTATO (*Ipomoea batatas*)

BACTERIAL Soft Rot. **Erwinia carotovora**, CT, SC.

BLIGHT, Leaf. **Phyllosticta batatas**, occasional NJ to FL, TX, KS, usually in the South; **Choanephora cucurbitarum**, FL, leaf mold.

BLIGHT, Southern; Cottony Rot. **Sclerotium rolfsii**, general in South.

CANKER, Stem. **Fusarium solani**, NC.

LEAF SPOT. **Alternaria** sp., secondary, occasional to general; **Cercospora** sp., FL, OK; **Septoria bataticola**, Occasional NJ to AL, IA, TX.

LEAF SPOT, Blight. **Acremonium crotocinigenum** (= *Cephalosporium cinnamomeum*), CA, FL.

NEMATODE, Lance. **Hoplolaimus coronatus**; Lesion, **Pratylenchus** sp.

NEMATODE, Root Knot. **Meloidogyne incognita** and **M. incognita-acrita**.

NEMATODE, Stem, Bulb. **Ditylenchus dipsaci**, causing brown ring, NJ.

NEMATODE, Sting. **Belonolaimus gracilis**.

NEMATODE, Stunt. **Tylenchorhynchus claytoni**.

NONPARASITIC. **Internal Breakdown**. Perhaps from chilling.
Internal Brown Spot. Boron deficiency.
Intumescence. High water intake and retarded transpiration.

ROT, Black. **Ceratocystis fimbriata**, general on roots, stems; **Diplodia theobromae** (*Physalospora rhodina*), Java black rot, general in South.

ROT, Charcoal. **Macrophomina phaseoli**, NJ to FL, TX, CA, KS.

ROT, Gray Mold. **Botrytis cinerea**, on sprouts, cosmopolitan.

ROT, Root. **Diaporthe batatis**, dry rot, stem rot, NJ to FL, MO, TX; **Helicobasidium purpureum**, KS, TX; **Pyrenochaeta terrestris**, pink root, CA; **Phymatotrichum omnivorum**, AZ, NM, OK, TX; **Phytophthora** sp., NJ, PA; **Plenodomus destruens**, foot and storage rot, NJ to FL, CA, IA, LA; **Pythium** spp., mottle necrosis, leak, ring rot; **Fusarium solani**, NC; **Geotrichum candidum**, LA, NC.

ROT, Soil; Pox. **Streptomyces ipomoea**, general, NJ to FL, TX, AZ, CA, IA.

ROT, Sprout; Stem Canker. **Rhizoctonia solani**, occasional, NJ to FL, AZ, CA, OH, TX, WA.

ROT, Storage. **Fusarium** spp., general; **Mucor racemosus**, occasional after chilling; **Penicillium** sp., blue mold, cosmopolitan; **Rhizopus** spp., soft rot, general; **Sclerotinia** sp., NC; **Trichoderma** spp., DE, NJ; **Aspergillus** spp., secondary.

RUST. **Coleosporium ipomoeae** (II, III), AL, MS; 0, I on pine.

SCURF. **Monilochaetes infuscans**, general.

SLIME MOLD. **Fuligo violacea**, AL, DE, NJ, TX; **Physarum cinereum**; **P. plumbeum**, AL, AR, KY, MS, NC, VA.

VIRUS. **Sweetpotato Feathery Mottle** (Yellow Dwarf); **Sweetpotato Internal Cork**, GA, LA, MD, MS, NC, SC, TN, VA; **Sweetpotato Mosaic** (Tobacco Mosaic); **Tobacco Ring Spot**; **Beet Curly Top**; **Sweetpotato Russet Crack**.

WHITE RUST. **Albugo ipomoeae-panduratae**, general.

WILT. **Fusarium oxysporum** f. sp. **batatas**, stem rot, general; **Verticillium albo-atrum**, CA.

Select varieties resistant to Fusarium stem rot, in general the Spanish group. Heat treatment eliminates some viruses. Hot water (10 minutes at 120°F) controls scurf. Variety Nemagold is resistant to root-knot nematodes.

SWEET-ROOT (*Osmorhiza*)

LEAF GALL. **Urophlyctis** (*Physoderma*) **pluriannulata**, MT.
LEAF SPOT. **Cercospora osmorhizae**, IL, OH, WI; **Fusicladium angelicae**, WA; **Phloeospora osmorhizae**, IA, NY, WI; **Ramularia reticulata**, WI, VA; **Septoria aegopodii**, NY, ND, OH, WI.
RUST. **Puccinia pimpinallae** (0, I, II, III), general.

SWEET VETCH (*Hedysarum*)

BLACK MILDEW. **Parodiella perisporioides**, NY.
LEAF SPOT. **Septogloeum hedysari**, WY.
NEMATODE, Root Knot. **Meloidogyne** sp.
RUST. **Uromyces hedysari-obscuri** (0, I, II, III), AK, CO, ID, MT, NM, SD, UT, WY.

SWEET WILLIAM (*Dianthus barbatus*)

ANTHRACNOSE. **Volutella dianthi**, DE, IN, NY.
BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Cutting. **Cylindrocladium scoparium** and **C. floridanum**, FL, OH.
BLIGHT, Southern. **Sclerotium rolfsii**, CT, FL, NC.
LEAF SPOT. **Phyllosticta** sp. (*Ascochyta dianthi*), WA; **Septoria dianthi**, AL, IA, MI, NY.
NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, OR.
NEMATODE, Root Knot. **Meloidogyne** sp., FL, TX.
ROT, Root. **Pythium ultimum**, CA; **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Rhizoctonia solani**, CT, IL, KS, MA, MS, NJ, NY, PA, TX.
RUST. **Uromyces dianthi** (II, III), IA, NE, TX; **Puccinia arenariae** (III), AL, CT, MA, NY, PA.
VIRUS. **Carnation Mosaic**; **Beet Curly Top**, CA, TX.
WILT. **Fusarium oxysporum** f. sp. **barbati**, CA, KS; **Fusarium** sp., MA, NJ, SC, VA.

Fusarium wilt is one of the more serious diseases with the new growth yellowing, the leaves pointing downward, and plants stunted. Place new plants in a new location or sterilized soil.

SWISS CHARD (*Beta vulgaris* var. *cicla*)

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **aptata**, CA.
BLIGHT, Southern. **Sclerotium rolfsii**, LA, SC.
BLIGHT, Phytophthora. **Phytophthora capsici**, IL.
DAMPING-OFF, Root Rot. **Rhizoctonia solani**, NY; **Pythium aphanidermatum**, CA.
DOWNY MILDEW. **Peronospora schachtii**, CA.
LEAF SPOT. **Cercospora beticola**, general; **Ramularia beticola**, WA.
MOLD, Seed. **Alternaria tenuis**, CA; **Stemphylium botryosum**, CA, WA.
NEMATODE, Root Knot. **Meloidogyne** sp., LA.
NONPARASITIC. **Heart Rot**; Cracked Stem. Boron deficiency, NY, WA.
ROT, Crown. **Sclerotinia** sp., MS.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Uromyces betae** (II), CA, OR.
VIRUS. **Beet Curly Top**, AZ, CA, OR; **Beet Mosaic**, AZ, CA, WA; **Yellow Net**, unidentified, CA.

SWINE CRESS (*Coronopus*)

ROT. **Sclerotinia minor**. NC.

SWITCHGRASS (*Panicum*)

BLOTCH, Spot. **Helminthosporium sativum** (*Bipolaris sorokinianum*), PA.
LEAF SPOT. **Bipolaris sacchari**, FL; **Rhizoctonia zeae** (also sheath spot), RI.
ROT, ROOT. **Pythium arrhenomanes**, LA.
SMUT. **Tilletia maclaganii**, IA.
VIRUS. **Barley Yellow Dwarf**.

SYCAMORE

► Plane.

SYNGONIUM

ANTHRACNOSE. **Gloeosporium** sp., WA; **Colletotrichum** sp., WA.
BACTERIAL Blight. **Xanthomonas campestris**, MD.
BACTERIAL Leaf Spot. **Xanthomonas dieffenbachiae**, FL; **X. vitians**, FL.
LEAF SPOT. **Cephalosporium cinnamomeum**, NY.
ROT; Black Cane. **Ceratocystis fimbriata**, CA.

SYNTHYRIS

LEAF SPOT. **Ramularia** sp., OR.
RUST. **Puccinia acrophila** (III), MT to CO, UT; **P. welfeniae** (III), CA, ID, OR, WA, WY.

TABEBUIA (Trumpet-Tree)

RUST. **Prospodium plagiopus** (II, III), FL.

TABERNAEMONTANA (Crape-Jasmine)

LEAF SPOT. **Gloeosporium tabernaemontanae**, FL.
LEAF SPOT, Algal; Green Scurf. **Cephaleuros virescens**, FL.
LEAF MOLD. **Cladosporium** sp., FL.
ROT, Mushroom Root. **Clitocybe tabescens**, FL.

TAENIDIA

LEAF SPOT. **Fusicladium angelicae**, WI; **Septoria pimpinellae**, MN.
RUST. **Puccinia angelicae** (0, I, II, III), IN, MI, MO, NY, WI.

TAHITIAN BRIDAL VEIL (*Gibasis*)

VIRUS. **Bean Yellow Mosaic**, VA.

TAMARIND (*Tamarindus*)

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

TAMARISK, SALT CEDAR (*Tamarix*)

BACTERIAL Blight. Fatal to some plants in AZ, NM, TX, where the host has become a noxious weed.
POWDERY MILDEW. **Sphaerotheca macularis**, IN.
ROT, Root. **Phymatotrichum omnivorum**, CA, TX.
ROT, Wood. **Polyporus sulphureus**, MD.

TANSY (*Tanacetum*)

LEAF SPOT. **Ramularia tanaceti**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, PA.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
RUST. **Puccinia tanaceti** (0, I, II, III), WY; 0, I, II, III on **Artemisia**; II on chrysanthemum.

TEASEL (*Dipsacus*)

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
DOWNY MILDEW. **Peronospora dipsaci**, MO.
LEAF SPOT. **Cercospora elongata**, MD, NY to MO, WA.
NEMATODE, Leaf and Stem. **Ditylenchus dipsaci**, CA, OR.
POWDERY MILDEW. **Phyllactinia corylea**, WA; **Sphaerotheca dipsacearum**, WA.
ROT Root. **Phymatotrichum omnivorum**, TX.
ROT Stem. **Sclerotinia sclerotiorum**, TX.
VIRUS. **Teasel Mosaic**.

TEA (*Thea sinensis*)

BLIGHT, Twig. **Pestalotia guepini**, also leaf spot, SC.
LEAF SPOT, Algal; Green Scurf. **Cephaleuros virescens**, FL, SC.
SPOT ANTHRACNOSE; Scab. **Sphaceloma** sp., LA; **Elsinoë leucospila**, FL.

TELLIMA

POWDERY MILDEW. **Sphaerotheca macularis**, AK.
RUST. **Puccinia heucherae** (III), AK, CA, OR, WA.

TERNSTROEMIA

SPOT ANTHRACNOSE. **Elsinoë leucospila**, FL.

TEXASWEED (*Caperonia*)

CANKER, Stem. **Amphobotrys ricini**, TX.

THALIA

LEAF SPOT. **Cercospora thaliae**, LA.
RUST. **Puccinia thaliae** (II, III), FL.

THERMOPSIS (Bush-Pea, Golden-Pea)

LEAF SPOT. **Cercospora thermopsidis**, CO, MT; **Phoma thermopsidicola**, CA; **Ramularia sphaerpioides**, WA; **Stigmina thermopsidis**, CA.
POWDERY MILDEW. **Erysiphe polygoni**, Rocky Mts., and Pacific Northwest.
VIRUS. **Bean Yellow Mosaic** in false lupine (*Thermopsis caroliniana*), MN.

THISTLE (*Cirsium*)

LEAF SPOT. **Cercospora** spp., WA, KS, TX; **Phyllosticta cirsii**, NY, WA, WI; **Stagonospora cirsii**, WI; **Septoria cirsii**, VT to IN, TX, WI; **Alternaria chrysanthemi**, MT.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general; **Phyllactinia corylea**, WA; **Sphaerotheca macularis**, MD.
ROT, Root. **Rhizoctonia solani**, IL; **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia cirsii** (0, I, II, III), PA to NC, CA, OR, TX; **P. punctiformis** (0, I, II, III), ME to NJ, CA, OH, WA; **Uromyces junci** (0, I), MO, NE, ND.
SMUT, Inflorescence. **Thecaphora trailii**, CO, UT.
WHITE RUST. **Albugo tragopogonis**, NY to IA, LA, TX, WY.

THISTLE, BLESSED (*Cnicus*)

BLIGHT, Southern. **Sclerotium rolfsii**, GA.

THISTLE, CREEPING ("Canada") (*Cirsium arvense*)

POWDERY MILDEW. **Golovinomyces cichoracearum**, ID, OR.

THISTLE, IVORY AND MILK (Silybum)

RUST. **Puccinia punctiformis**, MD.
SMUT, Biological Control. **Microbotryum silybum**, MD.

THISTLE MUSK (*Carduus thoermeri*)

RUST. **Puccinia carduorum**, CA, MO, NV, OK, VA.

THLASPI

LEAF SPOT. **Alternaria brassicicola**, NY.

THOROUGHWAX (*Bupleurum*)

NEMATODE, Root Knot. **Meloidogyne** sp., CA.

THUJOPSIS (Hiba Arborvitae)

BLIGHT, Twig. **Phomopsis occulta**, CA.

THUNBERGIA (Clockvine)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, FL.
BACTERIAL, MLO. **Aster Yellows**, NY.
NEMATODE, Root Knot. **Meloidogyne** sp., FL.
VIRUS. **Broad Bean Wilt**, NY.

THYME (*Thymus*)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Corynespora cassiicola**, FL.
ROT, Root. **Rhizoctonia solani**, MA.

TI (*Cordyline terminalis*)

LEAF SPOT. **Phytophthora parasitica**, HI.

TIBOUCHINA (Glory-Bush)

ROT, Mushroom Root. **Clitocybe tabescens**, FL.

TIDESTROMINIA

ROT. **Macrophomina phaseolina**, AZ.

TIGRIDIA (Tiger-Flower)

BACTERIAL Scab. **Pseudomonas marginata**, MD.
NEMATODE, Bulb. **Ditylenchus dipsaci**.
ROT, Internal. **Fusarium oxysporum** f. sp. **gladioli**; storage, **Penicillium gladioli**.
VIRUS. **Tigridia Mosaic**, OR, WA.

TITHONIA

VIRUS. **Tomato Spotted Wilt-Lettuce Serotype**, GA.

TOMATO (*Lycopersicon*)

ANTHRACNOSE. **Glomerella phomoides** (*Colletotrichum coccodes*), chiefly ripe rot of fruit, sometimes on leaves, general, especially in Northeast; **Colletotrichum dematium** var. **truncata**, MS; **C. graminicola**, MS; **C. trichellum**, MS; **C. glycines**, MS; **C. gossypii**, MS.
BACTERIAL Blight. **Pseudomonas viridiflava**, FL; **P. huttiensis**, FL.

BACTERIAL Canker. **Clavibacter michiganense**, birds-eye spot, general, most frequent in North and West, Baja, Mexico.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**; in experiments, **A. rhizogenes**, hairy root.

BACTERIAL, MLO. **Aster Yellows**; **Tomato Big Bud**, NY.

BACTERIAL, Pith Rot. **Erwinia chrysanthemi**, MA; **Pseudomonas corrugata**, CA, FL, LA, MA; also Stem necrosis, FL, Mexico.

BACTERIAL, Seedling Blight. **Bacillus polymyxa**, NY.

BACTERIAL Soft Rot. **Erwinia aroideae** and **E. carotovora**, cosmopolitan.

BACTERIAL Speck. **Pseudomonas syringae** pv. **tomato**, occasional East and central states, also CA, OK, TX, VA; **P. syringae** pv. **tomato** race 1, CA.

BACTERIAL Spot. **Xanthomonas vesicatoria**, on fruit, leaves, sometimes stem cankers, northeastern, central, and southern states; **Xanthomonas campestris** pv. **vitians**, OH.

BACTERIAL Stem Rot. **Erwinia chrysanthemi**, FL.

BLIGHT, Aerial. **Pythium myriotylum**, FL.

BLIGHT, Gray Mold/Stem Canker. **Botrytis cinerea**, CA, Mexico.

BACTERIAL Wildfire. **Pseudomonas syringae** pv. **tabaci**, WI.

BACTERIAL Wilt. **Pseudomonas solanacearum**, general, MA to IL and southward.

BLIGHT, Blossom. **Sclerotinia** sp., CA, FL, NY, OH.

BLIGHT, Early; Collar Rot; Fruit Rot. **Alternaria solani**, general.

BLIGHT, Late; Fruit Rot. **Phytophthora infestans**, general in humid regions and seasons, especially East and Southeast.

BLIGHT, Southern. **Sclerotium rolfsii**, VA to FL and TX, CA, occasional in North.

BROOMRAPE. **Orobanche ludoviciana**, WY; **O. racemosa**, CA, NJ, NY.

CANKER, Stem. **Helminthosporium** sp., TX; **Myrothecium roridum**, also fruit rot, OH, TX, VA, WI.

DAMPING-OFF. **Rhizoctonia solani**, also collar rot, stem canker, cosmopolitan; **Pythium** spp., cosmopolitan.

DODDER. **Cuscuta** spp., CA, ID, MD, NY, TX.

DOWNY MILDEW. **Peronospora tabacina**, GA, NC, SC.

FRUIT SPOT. **Pullularia pullulans**, WV.

LEAF SPOT. **Ascochyta lycopersici**, DE, FL, NJ, NC, OR, VA, WI; **Septoria lycopersici**, general except Northwest; **Phyllosticta hortorum**, NY; **Cercospora** spp.; **Stemphylium solani**, gray leaf spot, FL, GA, IN, LA,

NJ, NC, SC, TN, TX, VA; **S. floridanum**; **Cladosporium oxysporum**, NY; **Cristulariella moricola**, NY.

LEAF SPOT, Target, fruit necrotic pit, freckles. **Corynespora cassiicola**, FL.

MOLD, Leaf. **Botryosporium pulchrum**, PA, TX; **Chaetomium bostrychodes**, TX; **Cladosporium fulvum**, general under glass, occasional outdoors, IA.

NEMATODE, Awl. **Dolichodorus heterocephalus**.

NEMATODE, Dagger. **Xiphinema americanum**.

NEMATODE, Golden. **Heterodera rostochiensis** (*Globodera rostochiensis*); tobacco cyst, **H. tabacum**; soybean cyst, **H. glycines**, IA, MN, OH.

NEMATODE, Lance. **Hoplolaimus coronatus**.

NEMATODE, Lesion. **Pratylenchus pratensis**, MD, NJ.

NEMATODE, Reniform. **Rotylenchulus reniformis**.

NEMATODE, Root Knot. **Meloidogyne arenaria** var. **thamesi**; **M. hapla**, Pacific Northwest; **M. incognita**; **M. javanica**; **M. chitwoodi**, Pacific Northwest; **M. floridensis**, FL.

NEMATODE, Spiral. **Helicotylenchus nannus**.

NONPARASITIC. **Blossom-End Rot**. Unbalanced moisture and calcium deficiency, general.

Blotchy Ripening. Malnutrition, potassium deficiency.

Catface. Fruit abnormalities from growth disturbances.

Cloudy Spot. Feeding punctures of plant bugs.

Cuticle Crack. Of green fruit; high soil moisture and air temperature.

Fasciation. Genetic abnormality. Unbalanced nutrition.

Leafroll. Excessive soil moisture with starch congestion in leaves.

Oedema. Leaf hypertrophy from excessive water absorption and reduced transpiration.

Pockets; **Puffing**. Fruit defect from factors adversely affecting pollination and growth.

Psyllid Yellows. Toxemia from psyllid feeding. western states.

Russeting. Mite injury.

Sunscald. Fruit injury in heat on plants defoliated by disease.

Walnut Wilt. Toxemia from root excretions of walnut trees.

POWDERY MILDEW. **Erysiphe polygoni**, on seedlings indoors, NC; **Erysiphe** sp., CT, FL, NJ, NY, Canada; **Leveillula taurica**, AZ, CA, UT; **Oidiopsis taurica**, CA; **Oidium** sp., CA; **O. neolycopersici**, FL.

ROT, Black Root. **Thielaviopsis basicola**, CA.

ROT, Brown, Root. **Pyrenochaeta lycopersici**, MA.

ROT, Buckeye; Stem Rot. **Phytophthora parasitica**, MA to FL, AZ, CA, IL, TX; **P. cactorum**, NY, PA, WI; **P. capsici** United States, Mexico; **P. cryptogea**; **P. drechsleri**.

ROT, Charcoal. **Macrophomina phaseoli**, CA, TX.

ROT, Fruit. **Alternaria** sp., black mold; **Aspergillus** spp., green and yellow mold; **Alternaria alternata**, NY; **Brachysporium tomato**, KS, TX; **Cladosporium herbarum**, green mold; **Diaporthe phaseolorum**, MS, TX; **Diplodia theobromae**, AL; **Glomerella cingulata**, FL, LA, ME, MI, NJ, NY; **Isaria clonostachoides**, VA; **Mucor mucedo**, MD; **Nematospora coryli**, cloudy spot, CA, FL, GA; **Nigrospora oryzae**, CA; **Oospora lactis**, sour rot, cosmopolitan; **Phoma destructiva**, black spot, nearly general; **Pleospora lycopersici**, CA; **Rhizopus stolonifer**, cosmopolitan in transit; **Sclerotinia minor**, TX; **Sporotrichum** sp., IN, TX; **Trichothecium roseum**, MD, NC, OH; **Gibberella zeae**; **Phoma** sp.; **Myrothecium** sp.; **Eremothecium coryli**, CA.

ROT, Gray Mold; Ghost Spot. **Botrytis cinerea**, occasional on foliage, fruit, stems.

ROT, Nailhead Spot. **Alternaria tomato**, on fruit, stems, CT to FL, ND, TX.

ROT, Root. **Aphanomyces cladogamus**; **Colletotrichum atramentarium**, black dot; **Pyrenochaeta terrestris**, secondary, IA, IL, NJ; **Phymatotrichum omnivorum**, AZ, OK, TX; **Plectospira myriandra**, VA; **Thielaviopsis basicola**, TX.

ROT, Root. **Fusarium oxysporum**, FL, NE, NH, OH, (different from wilt); **F. oxysporum** f. sp. **radicis**, crown, FL, NH, OH, PA, TX. Also **F. oxysporum** f. sp. **radicis-lycopersici**, TX.

ROT, Root (and stunting of seedlings). **Pythium myriotylum** and **P. arrhenomanes**, FL.

ROT, Root and Wilt. **Colletotrichum coccodes**, CA.

ROT, Stem, Fruit. **Sclerotinia sclerotiorum**, occasional in greenhouses and in South; **Pythium myriotylum**.

SCAB, Powdery. **Spongospora subterranea**, PA.

VIRUS. **Tobacco Mosaic**, general, strains causing fernleaf and internal browning of fruit; **Cucumber Mosaic**, also causing shoestring; **Beet Curly Top**; **Western Yellow Blight**; **Tomato Aspermy**, AZ; **Tomato Ring Mosaic**; **Tomato Ring Spot**; **Tomato Spotted Wilt**, OK, TN;

Tomato Streak (Tobacco Mosaic plus Potato Virus X); **Tomato Yellow Net**; **Tomato Yellow Top**; **Witches' Broom**; **Tobacco Etch**, may cause severe mosaic; **Rugose Mosaic** (due to Potato Mottle Virus and Potato Virus Y); **Pseudo Curly Top**, FL; **Tobacco Streak**, CA; **Tomato Mosaic**, CA; **Tomato Mottle**, FL, SC, TN, VA; **Tomato Infectious Chlorosis**, CA; **Tomato Bushy Stunt**, CA; **Tomato Black Ring**; **Tomato Pseudo Curly Top**, FL; **Tomato Top Necrosis**, IL, IN, MO; **Tomato Yellow Leaf Curl Begomovirus**, CA, FL, GA, LA, MS, NC, SC, Sinaloa, Mexico; **Potato Spindle Tuber Viroid**, MD; **Serrano Golden Mosaic**, AZ; **Potato Leafroll**, Pacific Northwest; **Pepper Golden Mosaic**, CA, Mexico; **Pepino Mosaic**, AZ, CO, TX, Ontario Canada; **Tomato Chino La Paz**, Baja CA, Mexico.; **Tomato Severe Leaf Curl Begomovirus**, Mexico.

WART. **Synchytrium endobioticum**, PA (see under Galls).

WILT. **Fusarium oxysporum** f. sp. **lycopersici**, general, Mexico, Race 3, FL, TN; **Verticillium albo-atrum**, occasional in all regions.

Choose tomato varieties resistant to Fusarium wilt; purchase seed certified free from virus disease. In setting seedlings discard any showing galls of root-knot nematodes. Do not smoke while handling, and do not use tobacco stems as a mulch, although other mulches are helpful. Spray for late blight and other foliage diseases. State and federal agencies give warning when late blight is imminent and it is time to start spraying. See USDA Agricultural Handbook 203 for an excellent discussion of tomato diseases with fine illustrations.

TOMATILLO (*Physalis ixocarpa*)

VIRUS. **Tomato Spotted Wilt**, FL.

TORENIA

NEMATODE, Root Knot. **Meloidogyne** sp., MD.

POWDERY MILDEW. **Oidium** sp., LA.

TORREYA

LEAF SPOT. **Phomopsis** sp.

NEEDLE SPOT. **Fusarium lateritium**, FL.

NEEDLE SPOT, CANKER STEM. **Pestalotiopsis microspora**, FL.

TRADESCANTIA (Wandering Jew, Spiderwort)

BLIGHT, Gray Mold. **Botrytis cinerea**, AK.
LEAF SPOT. **Cladochytrium replicatum**, NY, secondary; **Colletotrichum** sp., NJ, TX; **Cylindrosporium tradescantiae**, IA; **Septoria tradescantiae**, WI to TX, SD.
NEMATODE, Root Knot. **Meloidogyne** sp., OR, TX.
RUST. **Uromyces commelinae** (II, III), TX.
VIRUS. **Tomato Spotted Wilt**, PA; **Tradescantia zebrina**, MN.

TRAUTVETTERIA (False Bugbane)

DOWNY MILDEW. **Peronospora ficariae**, TN.
LEAF SPOT. **Septoria trautveteriae**, WV.
RUST. **Puccinia pulsatillae**, ID, OR, WA.
SMUT, Leaf and Stem. **Urocystis anemones**, UT.

TREE-POPPY (*Dendromecon*)

SMUT, Leaf. **Entyloma eschscholtziae**, CA.

TREE-TOMATO (*Cyphomandra*)

BACTERIAL Canker. **Clavibacter michiganense**, CA.
POWDERY MILDEW. **Oidium** sp., MD.

TREFOIL, BIRDSFOOT (*Lotus*)

DECAY; Rot. Root, Stem. **Mycoleptodiscus terrestris**, DE, WI.
LEAF SPOT. **Cercospora zebrina** (clover isolate), NC.
RUST. **Uromyces** sp., PA, rust pustules were colonized by **Sphaerellopsis filum**.

TRILLIUM (Wake-Robin)

BLIGHT, Leaf. **Ciborinia trillii**.
BLIGHT, Tuber Storage Rot. **Sclerotinia sclerotiorum**, LA.

LEAF SPOT. **Colletotrichum peckii**, NY to NC, IL, MN; **Gloeosporium trillii**, CA, OR, WA; **Heterosporium trillii**, WA; **Phyllosticta trillii**, NY, PA, WA, WI; **Septoria trillii**, New England to OK, SC, WI.
ROT, Stem. **Sclerotium rolfsii**, NH, PA.
RUST. **Uromyces halstedii** (0, I), IL, NY; II, III on *Spartina*.
SMUT, Leaf. **Urocystis trillii**, ID, OR.

TRITONIA (*Montbretia*)

BLIGHT, Leaf. **Alternaria** sp., secondary, NH; **Heterosporium** sp., OR, WA.
BLIGHT, Southern. **Sclerotium rolfsii**, CA.
ROT, Corm. **Fusarium oxysporum** f. sp. **gladioli**, yellows; **Stromatinia gladioli**, in commercial stocks.
VIRUS. **Iris Mosaic**, CA, OR.

TROLLIUS (Globeflower)

LEAF SPOT. **Ascochyta** sp., NY; **Cylindrosporium montenegrinum**, WY; **Phyllosticta trollii**, WY.
SMUT, Leaf and Stem. **Urocystis anemones**, MD, NY.

TROPICAL SODA APPLE (*Solanum viarum*)

NEMATODE, Root Knot. **Meloidogyne arenaria**, FL.

TRUMPETVINE, TRUMPET-CREEPER (*Campsis*)

LEAF SPOT. **Cercospora duplicata**, LA; **Mycosphaerella tecomae** (*Cercospora sordida*), general; **Phyllosticta tecomae**, MS; **Myrothecium roridum**, TX; **Septoria tecomae**, OK, TX, WV.
MISTLETOE. **Phoradendron serotinum** (**flavescens**), TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, IL; **Microsphaera alni**, MD to AL, IN, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

TUBEROSE (*Polianthes*)

BACTERIAL Soft Rot. **Erwinia carotovora**, NC.

BLIGHT, Leaf and Flower Spot. **Botrytis elliptica**, CA.

LEAF SPOT. **Cercospora** sp., TX; **Helminthosporium** sp., also stem spot, TX.

NEMATODE, Root Knot. **Meloidogyne** sp., CA, FL, NC, TX, VA.

ROT, Root. **Pythium debaryanum**, TX; **Rhizoctonia solani**, NC.

TULIP (*Tulipa*)

ANTHRACNOSE. **Gloeosporium thuemenii** f. sp. **tulipi**, CA.

BACTERIAL Soft Rot. **Erwinia carotovora**, WA.

BLIGHT, Botrytis; Tulip Fire. **Botrytis tulipae**, general except for South and Southwest; **B. cinerea**, sometimes secondary.

BLIGHT, Southern; Bulb and Stem Rot. **Sclerotium rolfsii**, CA, CT, NY, OR.

NEMATODE, Bulb. **Ditylenchus dipsaci**, NY.

NONPARASITIC. **Chalking**, stone disease. Immaturity of bulbs or injury at digging.

Topple, Sugarstem. Collapse of flower stem, often from calcium deficiency.

ROT, Basal. **Fusarium** sp., OK, WA.

ROT, Black. **Sclerotinia sclerotiorum**, WA.

ROT, Bulb. **Penicillium** spp., blue mold; **Aspergillus** spp., black mold, cosmopolitan; **Rhizopus stolonifer**, mushy rot, cosmopolitan; **Sclerotinia** sp., ME, OH, WA; **S. sativa**, MD, NY; **Pythium ultimum**, secondary.

ROT, Gray Bulb. **Rhizoctonia tuliparum**, Northeast, Pacific states.

ROT, Root, Stem, Bulb. **Rhizoctonia solani**, MA, NY, WA.

ROT, Stem; Flower Spot. **Phytophthora cactorum**, CA, IA, NJ, PA, SC, WA.

VIRUS. **Tulip Breaking** (Lily Latent Mosaic and Tulip Color-adding), general; **Tobacco Necrosis**, WI.

Botrytis blight is extensive with tulips. In a wet spring, leaves are blasted, buds blighted, and open flowers covered with spots, followed by the familiar gray mold. Sanitary measures are all-important, for the sclerotia survive in the soil, ready to blight new, healthy bulbs. Cut off fading flowers into a paper

bag. Gradual running out of tulips may be due to virus disease. Breaking of flowers, once considered a desirable ornamental character, is now recognized as a disease that may be harmful in the long run. Unless aphids are controlled, the virus will spread from variegated to solid-color plantings in the garden.

TULIP-TREE, YELLOW POPLAR (*Liriodendron*)

BACTERIAL Root Lesion. **Pseudomonas** sp., OR.

BLIGHT, Seedling. **Rhizoctonia solani**, OH, VA.

CANKER. **Dothiorella** sp., PA; **Myxosporium** spp., NY; **Nectria** sp., WV to NC, TN; **Fusarium solani**, SC.

LEAF SPOT. **Cylindrosporium cercosporioides**, MD, WV; **Gloeosporium liriodendri**, CT to NJ, TX; **Mycosphaerella liriodendri**, GA, MI; **M. tulipiferae**, Middle Atlantic and Gulf states; **Phyllosticta liriodendrica** (conidial stage of *Mycosphaerella*), widespread; **Ramularia liriodendri**, AL, DE.

LEAF SPOT, Tar, Black. **Ectostroma liriodendri**, widespread; **Rhytisma liriodendri**, CA, TX, VA.

NEMATODE, Lesion. **Pratylenchus pratensis**, TX.

POWDERY MILDEW. **Phyllactinia corylea**, NY to AL, MO; **Erysiphe polygoni**, widespread.

ROT, Heart. **Collybia velutipes**, WV; **Ganoderma applanatum**, occasional.

ROT, Root. **Armillaria mellea**, VA; **Phymatotrichum omnivorum**, TX; **Cylindrocladium liriodendri**, CA.

ROT, Sapwood; Wood. **Daedalea extensa** and **D. unicolor**, sometimes on standing trees; **Daldinia vernicosa**, cosmopolitan; **Polyporus** spp.; **Schizophyllum commune**, wound rot; also many stain and timber rots.

ROT, Seedling Collar. **Cylindrocladium scoparium**, NJ, NC, TN.

SOOTY MOLD. **Capnodium elongatum**, cosmopolitan.

VIRUS. Chlorotic ringspot and vein banding, NC, SC.

The most conspicuous fungus on ornamental tulip-trees is the black sooty mold growing in copious honeydew secreted by tulip-tree aphids and scales. In hot, dry weather leaves sometimes turn yellow and drop prematurely. Leaf spots are seldom serious enough for treatment.

TUNG TREE (*Aleurites*)

ANTHRACNOSE. **Glomerella cingulata**, FL.

BLIGHT, Southern. **Sclerotium rolfsii**, TX.

BLIGHT, Thread. **Pellicularia koleroga**, FL, LA, MS, TX; Web, **P. filamentosa**, LA, MS.

CANKER; DIEBACK; Nut Rot. **Botryosphaeria ribis**, GA, LA; **Physalospora rhodina**, FL, LA, MS, TX.

CANKER, Felt Fungus. **Septobasidium pseudopedicellatum**, LA.

LEAF SPOT. **Cercospora websteri**, MS; **Gloeosporium aleuriticum**, MS; **Phyllosticta** sp., FL, GA, **Cristulariella pyramidalis**, FL.

LEAF SPOT, Angular. **Mycosphaerella** (*Cercospora*) **aleuritidis**, MS.

NEMATODE, Root Knot. **Meloidogyne** sp., AL, FL, MS.

NONPARASITIC. **Chlorosis**. Copper or potassium deficiency, FL.
Frenching. Manganese deficiency, FL.
Bronzing. Zinc deficiency, FL.
Wetwood. Alcoholic slime flux. Perhaps bacterial in part.
White Seed. Genetic abnormality.

ROT, Root, Collar. **Clitocybe tabescens**, serious throughout tung belt; **Cephalosporium** sp., LA; secondary; **Phytophthora cinnamomi**, LA.

ROT, Root; Collar Rot. **Cylindrocladium scoparium**, **C. crotalariae**, **C. floridanum**, MS.

Spraying is usually necessary for thread blight and nut rot.

TUPELO, SOUR GUM, BLACK GUM (*Nyssa*)

ANTHRACNOSE. **Colletotrichum acutatum**, GA.

BLIGHT, Thread. **Pellicularia koleroga**, LA.

CANKER. **Nectria galligena**, CT; **Strumella coryneoidea**, northern Appalachians; **Botryosphaeria ribis**, IL; **Fusarium solani**, LA.

CANKER, Felt Fungus. **Septobasidium** spp., NJ to Gulf states.

LEAF SPOT. **Actinopelte dryina**, AL, IL, OK; **Cercospora nyssae**, TX; **Mycosphaerella nyssaecola**, MA to GA, MI; **Phyllosticta nyssae**, southeastern states to TX.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), FL, IN, MD, TX.

ROT, Heart. **Ganoderma applanatum**; **Fomes connatus**, CT; **Hericium erinaceus**, NC.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Wood. **Daedalea confragosa**; **D. unicolor**, occasional; **Lentinus** spp., cosmopolitan; **Polyporus** spp.; **Stereum** spp.; **Trametes rigida**, Gulf states.

RUST. **Aplopsora nyssae** (II, III), MD to AL, TX.

WILT, Seedling. **Phytophthora cactorum**, MO.

TUPIDANTHUS

LEAF SPOT. **Alternaria panax**, CA.

TURNIP (*Brassica rapa*)

ANTHRACNOSE. **Colletotrichum higginsianum**, NY to FL, TX.

BACTERIAL Black Rot. **Xanthomonas campestris**, ME to FL, MN, TX.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, KS.

BACTERIAL Soft Rot. **Erwinia carotovora**, general in field, transit, storage.

BACTERIAL Spot. **Pseudomonas maculicola**, CT, GA, MA, TX; **Xanthomonas vesicatoria** pv. **raphani**, IN.

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **maculicola**, OH.

BLACKLEG. **Phoma lingam**, CT, MA, WA.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, TX.

CLUB ROOT. **Plasmodiophora brassicicola**, ME to NC, CA, CO, MN, TX, WA.

DAMPING-OFF. **Pythium ultimum**, WI; **Rhizoctonia solani**, also root, stem and storage rot, general.

DOWNY MILDEW. **Peronospora parasitica**, MA to FL, IL, TX.

LEAF SPOT. **Alternaria brassicae**, gray leaf spot, general; **A. oleracea**, black leaf spot, CT, FL, MD, MA, NJ, NC, TX; **Alternaria raphani**, AZ; **Cercospora brassicicola**, AL, FL, GA, MS; **Mycosphaerella brassicicola**, ring spot, OR; **Phyllosticta** sp., TX, WV; **Ramularia** sp., AL, FL, WA; **Septomyxa affine**, AL.

LEAF SPOT; White Spot. **Cercosporella brassicae**, MA to FL, IN, OR, TX; **Pseudocercosporella capsellae**, CA.

MOLD, Seed. **Alternaria tenuis**, cosmopolitan; **Stemphylium botryosum**, occasional; **Curvularia inaequalis**.

NEMATODE, Root. **Pratylenchus pratensis**, MD.

NEMATODE, Root Knot. **Meloidogyne** spp., AL, AZ, FL, OR, TX.
NONPARASITIC. **Brown Heart**. Boron deficiency, CA, MA, MN, VA, WI.
POWDERY MILDEW. **Erysiphe polygoni**, northeastern states to CA, FL, TX, WA; **Erysiphe cruciferarum**, WY.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Pythium** sp., NY.
ROT, Watery Soft. **Sclerotinia sclerotiorum**, CT, MD, MS, TX, WA.
SCAB. **Streptomyces scabies**, CT, MI, NJ, Canada.
SCAB ACID. **Streptomyces acidiscabies**, ME.
VIRUS. **Turnip Mosaic**, AL; **Beet Curly Top**, CA; **Radish Mosaic**.
WHITE RUST; White Blister. **Albugo candida**, general.
WILT; Yellows. **Fusarium oxysporum** f. sp. **conglutinans**, IN, MS, TX.
The control of turnip diseases is about the same as for cabbage and other crucifers.

TURPENTINE TREE (*Syncarpia*)

NEMATODE, Root Knot. **Meloidogyne** sp., FL.

TURTLE-HEAD (*Chelone*)

LEAF SPOT. **Septoria mariae-wilsonii**, ME to PA, OH, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, and **Erysiphe polygoni**, widespread.
RUST. **Puccinia andropogonis** var. **penstemonis** (0, I), CT, MA, NJ, NY, PA, TN; II, III on *Andropogon*; **P. chelonis** (III), OR, WA.
VIRUS. **Tomato Spotted Wilt**, PA.

UDO (*Aralia cordata*)

BLIGHT. **Alternaria** sp., DE, NJ.
ROT, Stem. **Sclerotinia sclerotiorum**, MD.
WILT. **Verticillium albo-atrum**, ME, PA.

UMBRELLA-PINE (*Sciadopitys*)

BLIGHT, Twig. **Diplodia pinea**, NJ.
LEAF SPOT. **Phyllosticta** sp., RI; **Cytospora** sp., OR.

ROT, Root; Damping-off. **Rhizoctonia solani**, CT.
ROT, Root; Wilt. **Phytophthora cinnamomi**, VA.

UMBRELLAWORT (*Oxybaphus*)

DOWNY MILDEW. **Peronospora oxybaphi**, KS, SD.
LEAF SPOT. **Ascochyta oxybaphi**, IA, WI; **Cercospora oxybaphi**, IL, IA, KS, NE, OH, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
WHITE RUST. **Albugo platensis**, AL.

UNICORN-PLANT, PROBOSCIS-FLOWER (*Proboscidea*)

BLIGHT, Southern. **Sclerotium rolfsii**, TX.
LEAF SPOT. **Cercospora beticola**, IA, KS, OK, TX, WI.
NECROSIS, Vascular. **Verticillium dahliae**, NM.
ROT, Root. **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotinia sclerotiorum**, MA.
VIRUS. **Bean Yellow Mosaic Virus**, NY. Also susceptible to **Cucumber Mosaic**, **Tobacco Etch**, **Tobacco Mosaic**, **Tobacco Necrosis**, **Tobacco Ring Spot**, **Tomato Ring Spot**, **Alfalfa Mosaic**, **Broad Bean Wilt**, **Lettuce Mosaic**, **Pea Seedborne Mosaic**, **Potato Virus Y**, **Turnip Mosaic**, **Watermelon Mosaic**.

UVULARIA (Bellwort, Merry-Bells)

LEAF SPOT. **Sphaeropsis cruenta**, CT, IL, IN, IA, MO, NY, VA, WI.
RUST. **Puccinia sessilis** (0, I), DE, IA, MN, MO, NY, ND, WI; **Uromyces acuminatus** var. **magnatus** (0, I), MS, WI.

VALERIAN, GARDEN HELIOTROPE (*Valeriana*)

LEAF SPOT. **Ramularia centranthi**, CA; **Septoria valerianae**, WI.
POWDERY MILDEW. **Golovinomyces cichoracearum**, CO, UT.
ROT, Root. **Rhizoctonia solani**, NY.
ROT, Stem. **Sclerotinia rolfsii**, CT, NJ.

RUST. **Puccinia commutata** (0, I, III), NY, OR; **P. dioicae** (0, I), CO, NM, UT; II, III on *Carex*; **P. valerianae** (II, III), AK.

VALERIAN, RED, JUPITERS-BEARD (*Centranthus*)

LEAF SPOT. **Ramularia centranthi**, CA.

VALERIANELLA (Corn-Salad or Lamb's Lettuce)

GALL, Leaf. **Synchytrium aureum**, MS.
LEAF SPOT. **Septoria valerianellae**, MS, TX.
POWDERY MILDEW. **Golovinomyces orontii**, CA.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Thielaviopsis basicola**, PA.
ROT, Stem and Crown. **Sclerotinia minor**, CA.

VANCOUVERIA

LEAF SPOT. **Phragmodothis berberidis**, CA; **Ramularia vancouveriae**, CA, OR.

VANILLA

BLACK MILDEW. **Lembosia rolfsii**, FL.
LEAF SPOT; Pod Spot. **Botryosphaeria vanillae**, FL; **Volutella vanillae**, FL.

VANILLA-LEAF (*Achlys*)

LEAF SPOT. **Ascochyta achlyicola**, WA; **Stagonospora achlydis**, OR.

VELVET BEAN (*Stizolobium*)

BACTERIAL Spot. **Pseudomonas syringae**, IN; **P. stizolobii**, NC.
BLIGHT, Southern. **Sclerotium rolfsii**, AL, FL, GA.
LEAF SPOT. **Cercospora stizolobii**, AL, FL, GA, NC, SC; **Mycosphaerella cruenta**, GA; **Phyllosticta macunae**, AL.

NEMATODE, Root Knot. **Meloidogyne** spp., CA, TX.
ROT, Pod Spot. **Fusarium** sp., TX.
ROT, Root. **Phymatotrichum omnivorum**, AZ, TX; **Phytophthora parasitica**, FL.

VENUS'S FLYTRAP (*Dionaea muscipula*)

ROT, ROOT. **Phytophthora cinnamomi**, NC.

VERATRUM (False-Hellebore)

LEAF SPOT. **Ascochyta veratrina**, WA; **Cylindrosporium veratrinum**, CA, NY, UT, VA, WA; **Cercosporella terminalis**, NY; **Phyllosticta melanoplaca**, CA, CT, ID, UT.
LEAF SPOT, Tar. **Phyllachora melanoplaca**, NY.
RUST. **Puccinia atropuncta** (II, III), MO, NC, OK, TN, VA, WV; 0, I on composites; **P. veratri**, widespread; 0, I on *Epilobium*.

VERBASCUM

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.

VERBENA, GARDEN (*Verbena hortensis*)

BLIGHT, Flower. **Botrytis cinerea**, MA.
NEMATODE, Root Knot. **Meloidogyne** sp., MD.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Charcoal. **Macrophomina phaseoli**, OK.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, NY; **Thielaviopsis basicola**, PA.
VIRUS. **Broad Bean Wilt**, FL; **Nemesia Ring Necrosis Tymovirus**, CA; **Angelonia Flower Break Carmovirus**.

VERBENA (Native Species)

BLIGHT, Web. **Rhizoctonia solani**, LA.
BREAK CARMOVIRUS.

BROOMRAPE. **Orobanche ramosa**, TX.
DODDER. **Cuscuta arvensis**, OK.
DOWNY MILDEW. **Plasmopara halstedii**, NM.
LEAF SPOT. **Ascochyta verbenae**, WI; **Cercospora verbenicola**, AL, LA, TX; **Phyllosticta texensis**, TX; **Septoria verbenae**, VT to MS, SD, TX.
POWDERY MILDEW. **Golovinomyces cichoracearum**, general.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia aristidae** (0, I), AZ; II, III on grasses; **P. vilfae** (0, I), IN to OK, SD; II, III on *Sporobolus*.
VIRUS. **Bean Yellow Mosaic**, CA; **Bidens Mottle**, FL; **Clover Yellow Mosaic**, FL; **Tomato Spotted Wilt**, GA; **Nemesia Ring Necrosis Tymovirus**, CA; **Angelonia Flower Break Carmovirus**.

VERBENA (*Nemisia diascia*)

NEMESIA RING NECROSIS. **Tymovirus**, CA; **Angelonia Flower Break Carmovirus**.

VERBESINA (Crownbeard)

DOWNY MILDEW. **Plasmopara halstedii**, NM, TX.
LEAF SPOT. **Cercospora fulvella**, TX; **Colletotrichum** sp., also stem spot; **Phyllosticta verbesinae**, TX.
NEMATODE, Root Knot. **Meloidogyne** sp., AL.
POWDERY MILDEW. **Golovinomyces cichoracearum**, SC, TX, VA.
ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.
RUST. **Coleosporium viguierae** (II, III), AZ, FL, NC, TX; 0, I unknown; **Puccinia abrupta** (II, III), CA, TX; **P. cognata** (0, I, II, III), AR, LA, TN, TX; **P. verbesinae** (0, I, II, III), MD to AL, LA.

VERONICA (Speedwell)

BACTERIAL, Proliferation. **Rhodococcus fascians**, OR.
DOWNY MILDEW. **Peronospora grisea**, CA, GA, KS, IL, IN, MO, NY, TX, WI.
GALL, Leaf. **Synchytrium globosum**, LA; **Sorosphaera veronicae**, CO, MS.

LEAF SPOT. **Cercospora tortipes**, WI; **Gloeosporium veronicae**, NY; **Ramularia veronicae**, OK, TX, WI; **Septoria veronicae**, CA, FL, IA, MI, OH, WI.
NEMATODE, Root Knot. **Meloidogyne** spp., FL.
POWDERY MILDEW. **Sphaerotheca macularis**, CT, IA, OR, WI.
ROT, Root and Stem. **Fusarium** sp., NJ; **Rhizoctonia solani**, IL, MD; **Phymatotrichum omnivorum**, TX.
ROT, Stem. **Sclerotium rolfsii**, CT, NJ, OH.
RUST. **Puccinia albulensis** (III), CO, MT, OR, UT, WA, WY; **P. probabilis** (II, III), NM; **P. rhaetica** (III), WA; **P. veronicarum** (III), IA, WI.
SMUT, Leaf. **Entyloma veronicae**, CO, CT, IL, IA, KS, MS, MO, NY, TX, WI; **Urocystis kmetiana**, GA.
VIRUS. **Cucumber Mosaic**, AR; **Tomato Spotted Wilt**, PA.

VETCH (*Vicia*)

BLIGHT, LEAF. **Ascochyta fabae** f. sp. **vicia**, CT.
LEAF SPOT, chocolate. **Botrytis fabae**, CT.
LEAF SPOT, **Ramularia sphaeroidea** (also stem), CA.
NEMATODE, Ring. **Mesocriconema** (formerly **Criconemella**), SC.
VIRUS. **Broad Bean Severe Chlorosis**, MI; **Broad Bean Wilt**.

VIBURNUM

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, PA, WA.
BACTERIAL Leaf Spot. **Pseudomonas viburni**, IL, IA, NJ.
BLIGHT. **Phytophthora ramorum**, OR, WA.
BLIGHT, Gray Mold; Shoot. **Botrytis cinerea**, MA, WA.
BLIGHT, Thread. **Pellicularia koleroga**, FL, NC.
CANKER, Stem Girdle. **Hymenochaete agglutinans**, PA.
DODDER. **Cuscuta compacta**, FL.
DOWNY MILDEW. **Plasmopara viburni**, general.
GALL, Stem; Dieback. **Phomopsis** sp., MD, NJ, NY.
LEAF SPOT. **Cercospora opuli**, IA, MS; **C. tinea**, LA; **C. varia**, general; **Helminthosporium beaumontii**, AL, TX; **Hendersonia foliorum** var. **viburni**, FL, TX; **H. tini**, LA; **Leptosphaeria tini**, LA; **Monochaetia desmazierii**, WV; **Phyllosticta lantanoides**, NY; **P. punctata**, FL, IA, WI; **P. tinea**, MD; **Ramularia viburni**, TN, WI.

LEAF SPOT. **Cristulariella pyramidalis**, MD.
LEAF SPOT, Algal. **Cephaleuros virescens**, FL, LA.
MOLD, Leaf. **Cladosporium herbarum**, OH, PA.
NEMATODE, Root Knot. **Meloidogyne** spp., CA, MD, MS.
POWDERY MILDEW. **Microsphaera alni**, general.
ROT, Root. **Clitocybe tabescens**, FL; **Corticium falactinum**, MD; **Phymatotrichum omnivorum**, TX; **Rosellinia necatrix**, CA; **Phytophthora cinnamomi** VA.
RUST. **Aecidium rubromaculans** (0, I), FL; **Coleosporium viburni** (II, III), IL, IA, MD, MI, VA, WI; 0, I unknown; **Puccinia linkii** (III), AK, ID, MI, MT, NH, WA.
SPOT ANTHRACNOSE. **Sphaceloma viburni**, CA, WA.
WILT. **Verticillium albo-atrum**, IL, IN, OR, WA.

Viburnum carlesii is extremely sensitive to sulfur and may be injured even by spray drift from other plants.

VIDALIA SWEET ONION (*Allium*)

DOWNY MILDEW. **Peronospora destructor**, GA.
ROT, Bulb. **Botrytis tulipae**, GA.

VINCA (Periwinkle, Ground-Myrtle)

BACTERIAL, MLO. **Aster Yellows**, KS, TX.
BACTERIAL Stunt. **MLO**, AR, OK.
BLIGHT, Gray Mold. **Botrytis cinerea**, CT, WA.
BLIGHT, TWIG. **Colletotrichum dematium**, FL.
CANKER; DIEBACK. **Phomopsis lirella**, CT, MD, NJ, OH, PA, VA; **Phoma** sp., OR.
DODDER. **Cuscuta indecora**, TX.
FLOWER, Spot and Blight. **Choanephora cucurbitarum**, LA.
LEAF SPOT. **Alternaria** sp., PA, TX; **Colletotrichum** sp., FL; **Macrophoma vincae**, also dieback, IL, NY; **Phyllosticta** sp., CT, GA, NJ; **P. minor**, MD, NJ, NY, VA; **P. vincae-majoris**, CA; **Septoria vincae**, NJ, NY; **Volutella vincae**, NY, PA.
MOLD, Leaf. **Cladosporium herbarum**, ME, NY, PA.
NEMATODE, Dagger. **Xiphinema americanum**, WI.

NEMATODE, Root Knot. **Meloidogyne** sp., CA, KS, OH.
ROT, Root. **Phytophthora cactorum**, NC; **P. lateralis**, NC.
ROT, Root, Black. **Thielaviopsis basicola**, FL.
ROT, Root and Stem. **Rhizoctonia solani**, IL, MD, NJ, PA. **Phytophthora parasitica**, MD.
RUST. **Puccinia vincae** (0, I, II, III), MA, MI, NY, WA.
SPOT, Target. **Corynespora cassiicola**, FL.
VIRUS. **Cucumber Mosaic**, NJ; **Potato Yellow Dwarf**, CA; **Tomato Spotted Wilt-Impatiens Serotype**, FL, GA.
WILT. **Verticillium albo-atrum**, CA, OR.

VINCETOXICUM (Milkvine)

DOWNY MILDEW. **Plasmopara gonolobi**, MD to FL, TX.
LEAF SPOT. **Cercospora bellynckii**, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.
RUST. **Puccinia obliqua** (III), FL to KY, AZ, OK; **Uromyces asclepiadis** (II, III), IN, WV.

VIOLET (*Viola odorata* and Native Species)

ANTHRACNOSE. **Colletotrichum violae-tricoloris**, CT, MA, MS, NJ, NY, OH, PA.
BLIGHT, Southern. **Sclerotium rolfsii**, VA to FL, CA, CT, NY, TX, VT.
DOWNY MILDEW. **Bremiella megasperma**, FL, IL, IA, MN, NJ.
GALL, Leaf. **Synchytrium aureum**, NY, WI.
LEAF SPOT. **Alternaria violae**, CT to GA, TX, WI; **Ascochyta violicola**, AK; **A. violae**, IN, IA, PA, WI; **Centrospora acerina**, AK, CA; **Cercospora granuliformis**, ME to AL, OK, SD; **C. violae**, MA to FL, ND, TX; **Cryptostictis violae**, IL; **Cylindrosporium violae**, MT; **Heterosporium** sp., AK; **Marssonina violae**, MA to SC, IA, MN; **Phyllosticta violae**, MA to FL, CA, KS, MN; **P. nigrescens**, CA; **Ramularia lactea**, AK, CO, MS, MT; **R. agrestis**, NE, OR; **Septoria violae**, northeastern and North central states to AK, FL, KS, LA; **Ciborinia violae**.
NEMATODE, Lesion. **Pratylenchus pratensis**.
NEMATODE, Root Knot. **Meloidogyne** spp., FL to CA, occasional in North.

POWDERY MILDEW. **Sphaerotheca macularis**, CA, CO, ND, OR, WI, WY.

ROT, Root. **Fusarium oxysporum** f. sp. **aurantiacum**, FL, MS, OH; **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, FL, IL, MN, MS, NY; **Thielaviopsis basicola**, CT to MS, KS, MA, OH.

ROT, Wet; Gray Mold. **Botrytis cinerea**, AK, MD, OH.

RUST. **Puccinia violae** (0, I, II, III), general; **P. effusa** (III), CA; **P. ellisiana** (0, I), northeastern and North central states to AL, NM, WY; II, III on *Andropogon*; **P. fergussoni** (III), AK, CO, MT, UT; **Uromyces andropogonis**, (0, I), MS, NJ, NC, PA, TN, WV; II, III on *Andropogon*.

SOOTY MOLD. **Scorias spongiosa**, ME.

SPOT ANTHRACNOSE; Scab. **Sphaceloma violae**, ME to FL, KS, LA, OH, WA.

SMUT, Leaf and Stem. **Urocystis violae**, AK, CA, MN, TX, UT.

VIRUS. **Beet Curly Top**, TX.

Spot anthracnose is an important violet disease in many gardens with disfiguring scabby lesions on stems and leaves.

VIPERS-BUGLOSS (*Echium*)

LEAF SPOT. **Cercospora echii**; **Stemphylium** sp., NY.

ROT, Root. **Rosellinia** sp., CA.

ROT, Stem. **Sclerotinia sclerotiorum**, ND.

VIRGINIA CREEPER (*Parthenocissus quinquefolia*)

BLIGHT, Thread. **Pellicularia koleroga**, FL.

CANKER; DIEBACK. **Coniothyrium fuckelii**, WV; **Cladosporium** sp., NJ.

DOWNY MILDEW. **Plasmopara viticola**, AL, IA, ME, MN, NJ, NY, TX, WI.

LEAF SPOT. **Cercospora ampelopsidis**, widespread; **C. psedericola**, IL, VA; **Guignardia bidwellii** f. sp. **parthenocissi**, general; **Phloeospora ampelopsidis**, IL, IA, NE, WI.

PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, LA, southern US.

POWDERY MILDEW. **Uncinula necator**, general.

ROT, Root. **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.
SPOT ANTHRACNOSE. **Elsinoë parthenocissi**, FL, MO, NH, PA.
The Guignardia leaf spot is commonly disfiguring in a wet season.

VITEX (*Chaste-Tree*)

LEAF SPOT. **Cercospora viticis**, LA, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

WAHLENBERGIA (*Southern Rockbell*)

VIRUS. **Tomato Spotted Wilt**, GA.

WALLFLOWER (*Cheiranthus*)

BACTERIAL, MLO. **California Aster Yellows**, CA.
BLIGHT, Gray Mold. **Botrytis cinerea**, AK, WA.
LEAF SPOT. **Heterosporium** sp., OK.
ROT, Crown. **Rhizoctonia solani**, NJ.
WHITE BLISTER. **Albugo candida**, MN.

WALLFLOWER, WESTERN (*Erysimum*)

CLUB ROOT. **Plasmodiophora brassicae**, NJ.
DOWNY MILDEW. **Peronospora parasitica**, CO, ID, IA.
LEAF SPOT. **Cercospora erysimi**, WI.
POWDERY MILDEW. **Erysiphe polygoni**, CA.
ROT, Root. **Rhizoctonia solani**, TX.
RUST. **Puccinia aristidae** (0, I), AZ, CO, ND, NE, UT; **P. consimilis** (I, III), MT; **P. holboellii** (0, III), CO.
VIRUS. **Tomato Spotted Wilt**, CA.
WHITE RUST; White Blister. **Albugo candida**, ID, OR, TX.

WALNUT (*Juglans*) (Includes Butternut, Black, English, and Japanese Walnuts)

ANTHRACNOSE; Leaf Spot. **Gnomonia leptostyla** (*Marssonina juglandis*), general.

BACTERIAL Blight. **Xanthomonas juglandis**, NY to GA, TX, and Pacific Coast, especially on English (Persian) walnut.

BACTERIAL Canker. **Erwinia nigrifluens**, CA; **E. rubrifaciens**, phloem canker, CA; **Sirococcus clavigignenti-juglandacearum**, NC.

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, occasional.

BLIGHT, Leaf. **Cylindrosporium juglandis**, AL and TN to TX, CA.

BLIGHT, Seedling. **Sclerotium rolfsii**, TX.

CANKER; Branch Wilt. **Hendersonula toruloidea**, connected with sunburn.

CANKER; DIEBACK. **Diplodia juglandis**, widespread; **Dothiorella gregaria**, CA; **Exosporina fawcetti**, wilt, CA; **Melanconis juglandis**, widespread, especially in East; **Nectria** spp., widespread; **N. galligena**; **Cytospora** sp., AZ.

CANKER; Felt Fungus. **Septobasidium curtisii**, NC.

CANKER, Stem. **Fusarium solani**, KS.

LEAF SPOT. **Cercospora juglandis**, KS, MA; **Phloeospora multimaculans**, TX; **Marssonina californica**, CA; **Ascochyta juglandis**, ring spot; **Grovesinia pyramidalis**, IL, IA, MN, OH, WV; **Mycosphaerella juglandis**, IL, IN, IA, NC.

LEAF SPOT. **Cristulariella pyramidalis**, IL. Also on *Bidens frondosa* (beggar-ticks),*Campsis radicans* (trumpet vine), *Chenopodium ambrosioides* (Mexican tea), *Commelina diffusa* (dayflower), *Cuphea petiolota* (blue waxweed), *Desmodium canescens* (tick clover), *Eupatorium coelestinum* (mist-flower), *E. rugosum* (white snakeroot), *Ipomoea hederscea* (morning-glory), *I. lacunosa* (morning-glory), *Lobelia inflata* (Indian tobacco), *L. siphilitica* (blue cardinal-flower), *Perilla frutescens* (beefsteak plant), *Phytolacca arnericana* (poke), *Platanus occidentalis* (sycamore), *Polygonum pennsylvanicum* (smart weed), *P. scandens* (false buckwheat), *Rumex crispus* (yellow dock), *Sida spinosa* (prickly mallow), *Solidago canadensis* (goldenrod), *Vitis palmata* (Catbird grape)

LEAF SPOT; Downy Spot; White Mold. **Microstroma juglandis**, widespread; **M. brachysporum**, general; **Alternaria arborescens**, **A. al-**

ternata, **A. tenuissima** (leaf spot and brown/gray apical necrosis, AZ.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), IN southward, AZ, CA, NM.

MOLD, Nut. **Alternaria** sp., CA.

NEMATODE, Lesion. **Pratylenchus musicola**, CA; **P. vulnus**.

NEMATODE, Root Knot. **Meloidogyne** spp., TX.

NONPARASITIC. **Black End**, of Nuts. Probably drought injury, CA, OR.

Black Line, Girdle. Graft incompatibility.

Dieback. Boron deficiency, OR.

Erinose. Leaf galls from blister mites.

Leaf Scorch, **Sunscald**. NJ. OR, WA.

Little Leaf. Zinc deficiency, CA. Probably also causes Rosette.

Shrivel, Witches' Broom, Yellows. Cause unknown.

POWDERY MILDEW. **Phyllactinia corylea**, IN, OH, OR; **Microsphaera alni**, widespread; **Erysiphe polygoni**, CA.

ROT, Collar. **Phytophthora cactorum**, CA; **P. cinnamomi**, MD to AL, LA.

ROT, Heart. **Fomes igniarius** and **F. everhartii**, widespread; **Polyporus sulphureus**, widespread.

ROT, Root. **Armillaria mellea**, cosmopolitan; **Phymatotrichum omnivorum**, TX; **Cylindrocladium** sp., TN.

ROT, Wood. **Fomes conchatus**; **Polyporus** spp.; **Poria** spp.; **Schizophyllum commune**, cosmopolitan; **Daedalea confragosa**; **D. quercina**, widespread.

SCAB. **Cladosporium** sp., MD, MN.

VIRUS. **Brooming Disease**, DC, GA, MD, NY.

Bacterial blight is the most serious disease of walnuts on the Pacific Coast, requiring several sprays. A toxin, juglone, has been considered injurious to many shrubs growing in the vicinity of black walnut roots; the toxin also causes vascular wilt-like symptoms in eggplant and tomato in home gardens.

WATER-CRESS (*Nasturtium officinale*)

DAMPING-OFF. **Rhizoctonia solani**, TX.

LEAF SPOT. **Cercospora nasturtii**, CA, CT, FL, IN, NH, TX, WI.

ROT, Root. **Pythium debaryanum**, TX; **Sporgospora subterranea** f. sp. **nasturtii**, FL, PA; **Phytophthora cryptogea**, and stem, FL.

RUST. **Puccinia aristidae**, AZ, CO, TX.

VIRUS. **Western Aster Yellows Phytoplasma**, HI.
WHITE RUST; White Blister. **Albugo candida**, MN.

WATER-ELM (*Planera*)

ROT, Wood. **Daedalea ambigua**, SC; **Ganoderma lucidum**.

WATER-HOREHOUND (*Lycopus*)

GALL, Leaf. **Synchytrium cellulare**, WI.
LEAF SPOT. **Ascochyta lophanthi**, MA, WI; **Cercospora lycopi**, LA; **Phyllosticta decidua**, IA, OK, WI; **Septoria lycopi**, WI.
RUST. **Puccinia angustata** (0, I), ME to MD, KS, ND; II, III on grasses.

WATER-HYACINTHS (*Eichhornia*)

BLIGHT. **Aquathanatephorus pendulus** (*Rhizoctonia* stage), LA.
LEAF SPOT. **Cercospora piaropi**, FL.
ROT, Root and Crown. **Mycoleptodiscus terrestris**, FL.

WATER-LILY (*Nymphaea*)

LEAF SPOT. **Alternaria** sp., TX; **Cercospora exotica**, IL; **C. nymphaeacea**, scattered ME to TX, CA; **Helicoceras nymphaerum**, MD, NJ, NY; **Mycosphaerella pontederiae**, MI, VA; **Ovularia nymphaearum**, MD, NY, WA; **Phyllosticta fatiscens**, VT.
LEAF SPOT. **Dichotomophthoropsis nymphaerum**, MN; **Sclerotium** sp., MN.
ROT, Leaf and Stem. **Pythium** spp., MA, NY, WI.
SMUT, White. **Entyloma nymphaeae**, MA to VA, OK, WI.

WATER-LILY, YELLOW PONDLILY (*Nuphar*)

LEAF SPOT. **Dichotomophthoropsis nymphaerum**, MN.
LEAF SPOT. **Mycosphaerella pontederiae**, ME, MI, NY, VA, WI; **Phyllosticta fatiscens**, IA, NJ, NY, WI.
SMUT, White. **Entyloma nymphaeae**, CT, IL, MA, WI.

WATERMELON (*Citrullus*)

ANTHRACNOSE. **Colletotrichum lagenarium**, general, Pacific Coast; **C. orbiculare**, CA; **Marssonina melonis**, NY.

BACTERIAL, Angular Leaf Spot. **Pseudomonas pseudoalcaligenes** subsp. **citrulli**, GA.

BACTERIAL Fruit Blotch. **Acidovorax avenae** (syn. **Pseudomonas pseudoalcaligenes**) subsp. **citrulli**, DE, IL, IN, OR, TX.

BACTERIAL Rind Necrosis. **Erwinia** sp., TX.

BACTERIAL Soft Rot. **Erwinia aroideae**, WV; wilt, **E. tracheiphila**, rare.

BACTERIAL Spot. **Pseudomonas lachrymans**, MI.

BLIGHT, Gummy Stem; Fruit Spot. **Didymella bryoniae**, CA; **Mycosphaerella citrullina**, also stem-End rot, leaf spot, MA to FL, AZ, MO.

BLIGHT, Southern. **Sclerotium rolfsii**, also fruit rot, NC to FL, TX.

CANKER, Stem. **Myrothecium roridum**, GA.

DAMPING-OFF. **Rhizoctonia solani**, soil rot, leaf blight; **Pythium** spp., also blossom-end rot, foot rot.

DOWNY MILDEW. **Pseudoperonospora cubensis**, occasional from MA to FL, TX, WI; also CA.

FRUIT SPOT; Speck. **Cribropeltis citrullina**, IL.

LEAF SPOT. **Alternaria cucumerina**, general except Pacific Coast; **Cercospora citrullina**, NJ to FL, OH, TX; **Corynespora cassiicola**; **Myrothecium roridum**, GA.

NEMATODE, Root knot. **Meloidogyne arenaria**; **M. incognita**; **M. javanica**.

NONPARASITIC. **Blossom-End Rot**. Hot dry weather after cool, moist days. **Internal Browning**. Drought and nutritional deficiencies.

POWDERY MILDEW. **Golovinomyces cichoracearum**, AZ, CA, FL, GA, NY, NC, TX, VA. May make pimples in young fruit.

ROT. **Diplodia** spp., stem-end, gray; MD to FL, AZ, KS; **Fusarium scirpi**, occasional in market; **Helminthosporium** sp., TX; **Rhizopus** spp., mushy soft rot.

ROT, Charcoal. **Macrophomina phaseoli**, TX.

ROT, Root. **Acremonium** sp., CA; **Phymatotrichum omnivorum**, AZ, TX; **Thielaviopsis basicola**, OR, UT; **Monosporascus cannonballus**, CA.

ROT, Stem and Fruit. **Phytophthora cactorum**, AZ; **P. capsici**, CO; **P. citrophthora**, CA; **Sclerotinia sclerotiorum**, NJ, TX.

SCAB; Leaf Mold. **Cladosporium cucumerinum**, MD, NE.

VIRUS. **Watermelon Mosaic**, NY to FL, AZ, CA, IA, MI, TX, WA; **Beet Curly Top**; **Tobacco Ring Spot**; **Watermelon Stunt** (strain of squash mosaic); **Zucchini Yellow Mosaic**, CA; **Watermelon Curly Mottle**, AZ; **Papaya Ring Spot**, LA; **Squash Leaf Curl**, TX; **Lettuce Infectious Yellows**, AZ, CA, TX; **Tomato Spotted Wilt**, GA; **Cucurbit Leaf Crumple**, CA.

WILT. **Fusarium oxysporum** f. sp. **niveum**, general and Race 2, DE, IN, MD; Race 3, MD; **Verticillium albo-atrum**, CA, NH, OR; **Rhizoctonia solani AG-7**, IN.

Fusarium wilt is probably the major disease and resistant varieties are available. For anthracnose and leaf spots treat seed before planting, and start spraying or dusting when vines start to run.

WATER-PRIMROSE (Jussiaea)

LEAF SPOT. **Alternaria** sp. OK; **Cercospora jussiaeae**, AL, OK, TX; **Colletotrichum jussiaeae** AL, TX; **Septoria jussiaeae** AL, FL, LA, TX.

RUST. **Aecidium betheli**, CA; **Puccinia jussiaeae** (0, I, III), MS; **Uredo guaunabensis** (II), FL.

WATER SHIELD (*Brasenia*)

LEAF SPOT. **Dichotomophthoropsis nymphaearum**, MN.

WATSONIA

ROT, Root. **Armillaria mellea**, CA.

VIRUS. **Iris Mosaic**, CA.

WAX-MYRTLE, CANDLEBERRY (*Myrica cerifera*)

BLACK MILDEW. **Irene calostroma**, Gulf states; **Irenina manca**, MS; **Meliola manca**, FL.

BLIGHT, Seedling. **Rhizoctonia solani**, NJ.

DODDER. **Cuscuta compacta**, FL.
LEAF SPOT. **Cercospora dispersa**, NJ; **Colletotrichum acutatum**, FL; **Phyllosticta myricae**, NJ to FL, TX; **Septoria myricae**, NJ.
NEMATODE, Ring. **Hemicriconemoides wessoni**, FL.
PARASITIC LICHEN. **Strigula elegans** and **S. complanata**, LA, Southern US.
ROT, Root. **Clitocybe tabescens**, FL; **Phymatotrichum omnivorum**, TX.
RUST. **Gymnosporangium ellisii** (0, I), MA to MD; III on *Chamaecyparis*.
SOOTY MOLD. **Capnodium grandisporum**, FL.

WEIGELA

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD, MS.
BLIGHT, Twig. **Phoma weigelae**, WA.
LEAF SPOT. **Cercospora weigelae**, MD, MS, NJ; **Ramularia diervillae**, TN.
NEMATODE, Lesion. **Pratylenchus pratensis**.
NEMATODE, Root Knot. **Meloidogyne** sp., CA, MD, MS, TX.
ROT, Root. **Phymatotrichum omnivorum**, TX.

WHEAT (*Triticum*)

BLIGHT, Seedling. **Sclerotium rolfsii**, OK.
LEAF SPOT, Tan. **Pyrenophora tritici-repentis**, KS, Pacific Northwest.
ROT, Damping-Off, Stunting. **Pythium abappressorium**, WA.
RUST, Stripe. **Puccinia striiformis** f. sp. **tritici**, FL.

WHIPPLEA

DOWNY MILDEW. **Peronospora whippleae**, CA.

WHORTLEBERRY, BILBERRY (*Vaccinium* spp.)

BLIGHT, Twig; Berry Rot. **Monilinia ledi**, NY.
GALL, Leaf. **Exobasidium vaccinii**, occasional; **E. parvifolii**, stem gall, OR, WA; **E. vaccinii-uliginosi**, shoot gall, rose-bloom, OR.
LEAF SPOT, Tar. **Rhytisma vaccinii**, AK.

POWDERY MILDEW. **Microsphaera alni** var. **vaccinii**, AK, OR, WA, WY; **Podosphaera oxyacanthae**, AK.

ROOT, Rot. **Phytophthora cinnamomi**, VA; **P. nicotianae**, VA; **P. palmivora**, VA.

RUST. **Pucciniastrum** sp. (II), OR, WA; **P. goeppertianum** (III), witches' broom, general; 0, I on fir; **P. vaccinii** (II, III), general; 0, I on hemlock.

WILD GARLIC (*Allium vineale*); WILD MUSTARD (*Brassica kaber*)

WILT, Water-soaked foliage. **Sclerotinia minor**, NC.

WILD RICE (*Zizania*)

ANTHRACNOSE. **Colletotrichum sublineolum**, MN.

BACTERIAL Leaf Spot. **Pseudomonas syringae** pv. **syringae**, MN, Pacific Northwest; **P. syringae** pv. **zizaniae**, Pacific Northwest.

BLIGHT, HEAD. **Fusarium graminearum**, MN.

LEAF SPOT, Stem Lesion. **Bipolaris sorokiniana**, Pacific Northwest; **Sclerotium oryzae**, Pacific Northwest; **S. hydrophilum**, Pacific Northwest.

LEAF SPOT, Zonate. **Drechslera gigantea**, MN.

ROT, Crown, Root. **Phytophthora erythroseptica**, CA; Damping-off. **Pythium torulosum**, CA.

SMUT. **Entyloma lineatum**, Pacific Northwest; **Ustilago esculenta**, CA.

VIRUS. **Wheat Streak Mosaic**, MN.

WILDRYE (*Elymus*)

LEAF SPOT. **Pyrenophora trichostoma**, ND; **Septorium spraguei**, ND.

WILLOW (*Salix*) (Includes Weeping Willow, Pussy Willow)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, NJ, TX, VA.

BACTERIAL Wetwood. **Erwinia nimipressuralis**.

BLIGHT, Twig. **Diplodia salicina**.

BLIGHT, Willow. Complex of scab and black canker.

CANKER, Black. **Physalospora miyabeana**, New England, NY, WV.

CANKER, Twig and Branch. **Botryosphaeria ribis**, VA to GA, AR, CA; **Cryptodiaporthe salicina**, ME to VA, AK, CA, KS, OK, SD, WA; **Cryptomyces maximus**, bark blister; NM, UT; **Discella carbonacea**, twig blight, New England; **Dothiora polyspora**, CO; **Dothiorella** sp., AR, ND; **Macrophoma** spp., AR, KY, MS, NC, SC, TX; **Phomopsis salicina**, IA, MA, VA; **Physalospora gregaria**, WV; **Valsa** spp., twig canker; **V. sordida** (*Cytospora chrysosperma*), widespread; **V. salicina**, widespread; **V. nivea**, western states.

DODDER. **Cuscuta** spp., IA, NY, WA.

LEAF BLISTER. **Taphrina populi-salicis**, CA.

LEAF SPOT. **Ascochyta salicis**, CA; **Cercospora salicina**, IL, LA, MD, TX; **Ciborinia foliicola**; **C. wisconsinensis**; **Cylindrosporium salicinum**, MA to CO, MS, WI; **Gloeosporium** spp., also twig blight, CT, DE, MA; **G. salicis**, VT to NJ, MS, OR, WI; **Marssonina** spp., widespread; **M. kriegeriana**, WI; **M. apicalis**, CA; **Myrioconium comitatum**, WI; **Phyllosticta apicalis**, KS, WI; **Ramularia rosea**, CO, MT, WI; **Septogloeum salicinum**, AK, NY, WI; **S. maculans**, CA, MT; **S. salicis-fendlerianae**, ID; **Septoria** spp.; **S. salicicola**, AK, OR; **S. didyma**, WI.

LEAF SPOT, Tar. **Rhytisma salicinum**, MI.

MISTLETOE. **Phoradendron serotinum** (**flavescens**), AZ, CA, IN, NM, TX.

MISTLETOE, European. **Viscum album**, CA.

NEMATODE, Lesion. **Pratylenchus vulnus**, CA.

NEMATODE, Root Knot. **Meloidogyne** sp.

POWDERY MILDEW. **Uncinula salicis**, general; **Phyllactinia corylea**, WA.

ROT, Heart. **Daedalea confragosa**, widespread; **Fomes** spp.; **Polyporus farlowii**, TX to CA; **Trametes suaveolens**, New England to MT, AK.

ROT, Root. **Armillaria mellea**, CA, WA; **Helicobasidium purpureum**, TX; **Phymatotrichum omnivorum**, TX.

ROT, Sapwood; Wood. **Daedalea ambigua**; **Ganoderma lucidum**; **Pholiota** spp.; **Pleurotus** spp.; **Polyporus** spp.; **Schizophyllum commune**, cosmopolitan.

RUST. **Melampsora ableti-capraearum** (*M. epitea*) (II, III), general except far North; 0, I on fir; **M. arctica** (II, III), AK, CO, NH; **M. epitea**, MN; **M. paradoxa** (*M. bigelowii*) (II, III), ME to NC, AK, IA, NM; 0, I on larch; **M. ribesii-purpureae** (II, III), MT to CO, AK, CA; 0, I on *Ribes*.

SCAB, Gray; Blight. **Fusicladium saliciperdum** (*Venturia chlorospora*), New England to NJ, NC, PA.
SOOTY MOLD. **Capnodium** sp.
SPOT ANTHRACNOSE; Scab. **Sphaceloma murrayae**, CA, OR, WA, WI.
Willow scab, followed by black canker, forms a very destructive blight, killing many trees in New England.

WINGED BEAN (*Psophocarpus tetragonolobus*)

VIRUS. **Cucumber Mosaic**, FL; **Clover Yellow Vein**, MD.

WINTERBERRY (*Ilex verticillata*)

LEAF SPOT. **Physalospora ilicis**, NY.
LEAF SPOT, Tar. **Rhytisma concavum**, WI; **R. prini**, ME to MS, IL, WI.
POWDERY MILDEW. **Microsphaera alni**, WI.

WINTER CRESS (*Barbarea*)

BACTERIAL Black Rot. **Xanthomonas barbareae**, NY.
BACTERIAL, Yellows. **Spiroplasma citri**, IL.
DODDER. **Cuscuta gronovii**, NY.
DOWNY MILDEW. **Peronospora parasitica**, TX.
LEAF SPOT. **Cercospora barbarea**, WI; **Ramularia barbareae**, MA to NJ, OH, TX, WI; **Alternaria** sp., PA.
ROT, Stem. **Sclerotium rolfsii**, TX.
VIRUS. **Beet Curly Top**; **Potato Yellow Dwarf**.
WHITE RUST. **Albugo candida**, CA, TX.

WINTERGREEN, CHECKERBERRY (*Gaultheria procumbens*)

ANTRACNOSE. **Colletotrichum gloeosporioides**, British Columbia, Canada.
BLOTCH, Sooty. **Gloeodes pomigena**, WI.
FRUIT SPOT, Black Speck. **Leptothyrium pomi**, WI.
LEAF SPOT. **Cercospora gaultheriae**, NY, WI; **Pezizella oenotherae**, VA; **Discosia maculicola**, secondary; **Mycosphaerella gaultheriae**, ME to

MD, WV; **Phyllosticta gaultheriae**, general; **Schizothyrium gaultheriae**, ME to VA, WI; **Venturia arctostaphyli**, MD, MA, NJ, NY, VA.

POWDERY MILDEW. **Microsphaera alni**, WI.

WINTERGREEN, WAXFLOWER

► Pipsissewa.

WISTERIA (*Wistaria*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, CT, MD, TX.

CANKER, Stem. **Nectria cinnabarina**, CT.

LEAF SPOT. **Phyllosticta wistariae**, MA, MO, NJ, TX; **Septoria wistariae**, TX.

NEMATODE, Root Knot. **Meloidogyne** spp.

POWDERY MILDEW. **Golovinomyces cichoracearum**, TX.

ROT, Heart. **Pleurotus** sp., WV.

ROT, Root. **Phymatotrichum omnivorum**, TX.

VIRUS. **Wisteria Vein Mosaic**, MS, NY, TX. **Tobacco Mosaic**, RI.

WITCH-HAZEL (*Hamamelis*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, MD.

LEAF SPOT. **Discosia artocreas**, OK; **Gonatobotryum maculicola**, NH to WV, FL, WI; **Graphium hamamelidis**, NY to IN, TN; **Monochaetia desmazierii**, VA to GA, TN; **Mycosphaerella** sp., WV; **Phyllosticta hamamelidis**, CT to MS, TN, WI; **Ramularia hamamelidis**, NY to WV, OK, WI.

POWDERY MILDEW. **Phyllactinia corylea**, MI, WI; **Podosphaera biuncinata**, New England to IL and southward.

ROT, Wood. **Fomes scutellatus**, widespread; **Polyporus** spp.

WOLFBERRY (*Symphoricarpos occidentalis*)

BLACK KNOT. **Dibotryon symphoricarpi**, twig canker, ND.

LEAF SPOT. **Cercospora symphoricarpi**, MT, ND, WA; **Septoria symphoricarpi**, IA, MT, ND, WA.

POWDERY MILDEW. **Microsphaera diffusa**, general.
ROT, Collar. **Fomes ribis**, KS, ND.
RUST. **Puccinia crandallii** (0, I), CO, MT, ND, WY; II, III on grasses; **P. symphoricarpi**, MT.

WOOD-BETONY, LOUSEWORT (*Pedicularis*)

GALL, Leaf. **Synchytrium aureum**, WI.
LEAF SPOT. **Ramularia obducens**, CA; **Septoria cylindrospora**, WI.
POWDERY MILDEW. **Sphaerotheca macularis**, CA, CO, MD, MI, MN, WY, WI.
RUST. **Cronartium coleosporioides** (II, III), CA, ID, MT, NM, WA; **Puccinia clintonii** (III), CO, ID, ME, MI, NM, NY, OR, WA, WI, WY; **P. rufescens** (I, III), CA, CO, NV.

WOOD ROSE (*Rosa gymnocarpa, R. californica*)

LEAF SPOT, Lesions. **Phytophthora gymnocarpa**, CA.

WOODRUSH (*Luzula*)

RUST. **Puccinia obscura** (II, III), ME to KS, ID, OR, WA, WI.
SMUT, Inflorescence. **Cintractia luzulae**, IN.

WYETHIA

LEAF SPOT. **Didymaria conferta**, OR, UT; **Marssonina wyethiae**, CA, WA; **Septoria wyethiae**, CA, UT.
NEMATODE, Leaf Gall. **Tylenchus balsamophilus**, UT.
RUST. **Puccinia balsamorhizae** (0, I, II, III), AZ, CA, CO, UT.

XANTHOSMA

ROT, Root. **Armillaria mellea**, CA; **Fusarium solani**, powdery gray rot, FL.

XEROPHYLLUM (Turkeybeard)

RUST. **Puccinia atropuncta** (II, III), MS.

YAM, CINNAMON-VINE (*Dioscorea*)

LEAF SPOT. **Cercospora dioscoreae**, IL, IA, MD, MI, PA, WI; **Colletotrichum dioscoreae**, IL; **Phyllosticta dioscoreae**, SC, VA, WV; **Ramularia dioscoreae**, WI.
NEMATODE, Root Knot. **Meloidogyne** sp., NC.
ROT, Root. **Phymatotrichum omnivorum**, TX.

YARROW (*Achillea*)

BACTERIAL Crown Gall. **Agrobacterium tumefaciens**, IN.
DODDER. **Cuscuta** sp., NH.
POWDERY MILDEW. **Golovinomyces cichoracearum**, AK, MO, MT, PA, SD, VT, WI.
NEMATODE, Root Knot. **Meloidogyne** sp., OR.
ROT, Root. **Phymatotrichum omnivorum**, TX; **Rhizoctonia solani**, general.
RUST. **Puccinia millefolii** (III), CA, CO, ID, MT, NM, OR, UT, WA, WY.

YAUPON (*Ilex vomitoria*)

LEAF SPOT; Tar Spot. **Rhytisma ilicincola**, VA.
ROT, Root. **Phymatotrichum omnivorum**, TX.
SOOTY MOLD. **Capnodium** spp., Gulf states.

YELLOW-ROOT (*Xanthorhiza*)

LEAF SPOT. **Phyllosticta xanthorhizae**, NC, WV.

YELLOWWOOD (*Cladastris*)

POWDERY MILDEW. **Phyllactinia corylea**, OK.
ROT, Wood. **Polyporus spraguei**, MD.

VIRUS. **Bean Yellow Mosaic**, NY.
WILT. **Verticillium albo-atrum**, IL.

YERBA BUENA (*Micromeria*)

RUST. **Puccinia menthae** (0, I, II, III), CA, ID, OR, WA.

YERBA SANTA (*Eriodictyon*)

BLOTCH, Sooty. **Coniothecium eriodictyonis**, CA.

YEW (*Taxus*)

BLIGHT, Needle. **Herpotrichia nigra**, ID; **Sphaerulina taxi**, CA, ID, OR, WA; **S. taxicola**, also twig blight, NY, PA; **Alternaria** sp., CT, NY, RI; **Phyllosticta taxi**, VA; **Macrophoma taxi**; **Mycosphaerella taxi**; **Neopeckia coulteri**; **Cryptocline taxicola**, eastern United States.
BLIGHT, Seedling. **Phytophthora cinnamomi**, IN, MD, VA, Pacific Northwest.
BLIGHT, Twig. **Phyllostictina hysterella** (*Physalospora gregaria*); **Pestuloria** sp., PA; **P. funerea**, MA; **Sphaeropsis** sp. NJ; **Botryosphaeria ribis**.
DAMPING-OFF. **Rhizoctonia solani**, CT.
ROT, Heart. **Fomes hartigii** OR; **F. roseus**, ID.
ROT, Root. **Armillaria mellea**, ID; **Phytophthora cinnamomi**, OH; **P. lateralis**, CA.
ROT, Wood. **Polyporus schweinitzii**, ID.

YUCCA (Adams-Needle, Joshua-Tree, Spanish Bayonet)

BLIGHT, Flower. **Cercospora floricola** (*C concentrica*), TX.
BLIGHT, Leaf. **Kellermannia anomala**, secondary, general.
LEAF SPOT, **Cercospora concentrica**, CT, GA, IA, NJ, OK, TX; **Coniothyrium concentricum**, general; **Cylindrosporium angustifolium**, KS, MS, OK, TX; **Diplodia circinans**, TX; **Epicoccum asterinum**, TX; **Gloeosporium yuccogenum**, MO, TX; **Neottiospora yuccifolia**,

GA, WA; **Pestalozziella yuccae**, secondary, TX; **Phyllosticta** sp., TX; **Stagonospora gigantea**, CA; **Leptosphaeria obtusipora**.

MOLD, Leaf. **Torula maculans**, AZ, CA, SC, TX; **Alternaria tenuis**, leaf rot.

NEMATODE. **Meloidogyne** sp., OR.

ROT, Stem. **Sclerotium rolfsii**, MD.

RUST. **Puccinia amphigena** (0, I), NE.

Many other fungi are found on dead leaves and stems.

ZAMIA (Coontie)

ALGAE. **Anabaena cycadeae**, in coralloid roots, FL.

NEMATODE. **Meloidogyne** sp., FL.

ZAUSCHNERIA (Fire-Chalice, California Fuchsia)

RUST. **Puccinia oenotherae** (0, I, II, III), CA, UT.

ZEBRA PLANT (*Aphelandra*)

NONPARASTITIC. **Leaf Crinkle**; **Shortened Internodes**, **Axillary Bud Proliferation**, TX.

ROT, STEM. **Phytophthora parasitica**, FL.

ZEPHYRANTHES (Atamasco-Lily, Zephyr-Lily)

LEAF SCORCH; Red Spot. **Stagonospora curtisii**, CA.

LEAF SPOT. **Colletotrichum liliacearum**, NC.

ROT, Dry; Scale Speck. **Sclerotium** sp., OR.

RUST. **Puccinia cooperiae** (0, I, II, III), AL, FL, NC, TX.

ZIGADENUS

RUST. **Puccinia atropuncta** (II, III), IA, MO, ND, TX, WI; 0, I on composites; **P. grumosa** (0, I, II, III), CO, MT, WY; **Uromyces zygadeni** (0, I, II, III), CA, CO IA, KS, MT, NV, TX, UT, WA, WY.

SMUT, Leaf. **Urocystis flowersii**, UT.

ZINNIA

BACTERIAL; Leaf Spot, Flower Spot. **Xanthomonas campestris** pv. **zinniae**, LA.

BACTERIAL, MLO. **Aster Yellows**, MI, PA, and **California Aster Yellows**, CA.

BACTERIAL Wilt. **Pseudomonas solanacearum**, FL.

BLIGHT. **Alternaria zinniae**, CO, CT, NJ, NY, PA, SC.

BLIGHT, Flower. **Alternaria alternata**, TX.

BLIGHT, Head; Stem Canker. **Botrytis cinerea**, CA, CT, NJ, OR, PA.

BLIGHT, Southern. **Sclerotium rolfsii**, FL, NJ.

DAMPING-OFF; Root Rot. **Rhizoctonia solani**, CA, NJ, TX.

LEAF SPOT. **Cercospora zinniae**, SC to FL, CO, IN, PA, TX.

LEAF SPOT, Bacterial. **Xanthomonas nigromaculans** f. sp. **zinniae**, NC, OH.

NEMATODE, Leaf. **Aphelenchoides ritzemabosi**, DE, MA, NJ.

NEMATODE, Lesion. **Pratylenchus nannus**, MD; **P. penetrans**, NJ.

NEMATODE, Root Knot. **Meloidogyne** sp., NJ, PA, TX.

POWDERY MILDEW. **Golovinomyces cichoracearum**, general.

ROT, Blossom. **Choanephora** sp., FL.

ROT, Charcoal. **Macrophomina phaseoli**, TX.

ROT, Root. **Phymatotrichum omnivorum**, TX.

ROT, Stem; Wilt. **Fusarium** sp., CO, IA, MO, NY; **Phytophthora cryptogea**, NJ; **Sclerotinia sclerotiorum**, CA, CO, MA, MT, OR, PA, WA.

VIRUS. **Cucumber Mosaic**; **Beet Curly Top**; **Tobacco Etch**, FL; **Tomato Spotted Wilt**; **Bidens Mottle**, FL; **Potato Leafroll**, Pacific Northwest; **Sunflower Mosaic**, TX.

Powdery mildew in late summer is the most common zinnia disease.

ZIZIA (Meadow Parsnip)

GALL, Leaf. **Urophlyctis** (*Physoderma*) **pluriannulata**, IA, WI.

LEAF SPOT. **Ascochyta thaspii**, WI; **Cercospora ziziae**, PA, WI; **Cylindrosporium ziziae**, ND, WA, WI; **Septoria ziziae**, ND.

POWDERY MILDEW. **Erysiphe polygoni**, PA, WV.

RUST. **Puccinia ziziae** (III), WA.

ZOYSIA (Japanese Lawn Grass)

LEAF YELLOWING, Root Mass Reduction. **Gaeumannomyces graminis** var. **graminis**.

NEMATODE, Pseudo Root Knot. **Hypsoperine graminis**, MD.

ROT, Root and Crown. **Rhizoctonia solani**, MD; **Helminthosporium tetramera**; **Curvularia** spp.; **Fusarium** spp; **Gaeumannomyces graminis** var. **graminis**, TX.

RUST. **Puccinia zoysiae**, AL, AR, FL, GA, LA, MD, MO, MS, TX.

List of Land-Grant Institutions and Agricultural Experiment Stations in the United States

For help in diagnosing and controlling plant diseases contact your County Ag Comissioners (CA) or county extension agent, your state Diagnostic Lab, your state Department of Agriculture or your Cooperative Extension Specialist.

Alabama: Auburn University, Auburn, AL 36849.
http://www.aces.edu/dept/plantdiagnosticlab/
Alabama Cooperative Extension Service
http://www.aces.edu/plantlabbham/
Alaska: University of Alaska and Alaska Depertment of Agriculture
http://www.dnr.state.ak.us/ag/index.htm
Arizona: University of Arizona, Tucson, AZ 85721.
http://ag.arizona.edu/PLP/plpext/
Arkansas: University of Arkansas, Fayetteville, AR 72701.
http://www.aragriculture.org/pestmanagement/diseases/clinic/default.asp
California: Department of Food and Agriculture oratory and plant pest Diagnostic Center. (sgaimari@cdfa.ca.gov)
Colorado: Colorado State University, Fort Collins, CO 80523.
http://www.coopext.colostate.edu/jeffco/hort/clinic.htm
Connecticut: University of Connecticut, Storrs, CT 06269.
(http://pronewengland.org)
Delaware: University of Delaware, Newark, DE 19716.
http://ag.udel.edu/extension/pdc/index.htm
District of Columbia: See Rutgers. http://www.rcs.rutgers.eon/services/
Florida: University of Florida, Gainesville, FL 32611.
http://plantpath.ifas.ufl.edu/
Georgia: University of Georgia, Athens, GA 30602.
http://www.plant.uga.edu/Extension/Clinics/PDC.htm
Hawaii: University of Hawaii, Honolulu, HI 96822.
http://www2.ctahr.hawaii.edu/adsc/

Idaho: University of Idaho, Extension Service, Parma, ID 83660.
http://www.uidaho.edu/ag/plantdisease/
llinois: University of Illinois, Urbana, IL 61802.
http://plantclinic.cropsci.uiuc.edu/
Indiana: Purdue University, West Lafayette, IN 47907.
http://www.ppdl.purdue.edu
Iowa: Iowa State University, Ames, IA 50011.
http://www.isuplantdiseaseclinic.org
Kansas: Kansas State University, Manhattan, KS 66506.
http://www.plantpath.k-state.edu/DesktopDefault.aspx?tabid=49
Kentucky: University of Kentucky, Lexington, KY 40546.
http://www.ca.uky.edu/agcollee/plantpathology/extension/pdd_lab.html
Louisiana: Louisiana State University, Baton Rouge, LA 70803.
http://www.lsuagcenter.com/en/our_offices/departments/PlantPathology_Crops_Physiology/Plant_Disease_Clinic/
Maine: University of Maine, Orono, ME 04473. http://pmo.umext.main.edu
Maryland: University of Maryland, College Park, MD 20742.
http://www.plantclinic.umd.edu/
Massachusetts: University of Massachusetts, Amherst, MA 01003.
(umassextension.org)
Michigan: Michigan State University, East Lansing, MI 48824.
http://www.pestid.msu.edu/
Minnesota: University of Minnesota, St. Paul, MN 55108.
http://www.extension.umn.edu/distribution/cropsystems/DC3170.html
Mississippi: Mississippi Cooperative Extension Service, Mississippi, MS 39762. http://www.extensionplantclinics.msstate.edu/
Missouri: University of Missouri, Columbia, MO 65211.
http://soilplantlab.missouri.edu/
Montana: Montana State University, Bozeman, MT 59717.
http://scarab.msu.montana.edu/ipm/
Nebraska: University of Nebraska, Lincoln, NE 68583.
http://plantpath.unl.edu/ppathdiagnostic.htm
Nevada: University of Nevada, or Nevada Department of Agriculture.
http://www.nevada.gov/
New Hampshire: University of New Hampshire, Durham, NH 03824.
http://ceinfo.unh.edu/Agric/AGPDTS/PlantH.htm
New Jersey: Rutgers, The State University, Milltown, NJ 08850.
http://www.rce.rutgers.edu.services/

New Mexico: New Mexico State University, Las Cruces, NM 88003. http://plantclinic.nmsu.edu
New York: Cornell University, Ithaca, NY 14853. http://plantclinic.cornell.edu
North Carolina: North Carolina State University, Raleigh, NC 27695. http://www.ncsu.edu/pdic
North Dakota: North Dakota State University, Fargo, ND 58105. http://www.ag.ndsu.nodak.edu/diaglab/
Ohio: Ohio State University, Columbus, OH 43210. http://ppdc.osu.edu
Oklahoma: Oklahoma State University, Stillwater, OK 74078. http://entoplp.okstate.edu/Pddl/
Oregon: Oregon State University, Corvallis, OR 97331. http://web.science.oregonstate.edu/bpp/Plant_Clinic/index.htm
Pennsylvania: The Pennsylvania State University, University Park, PA 16802. http://www.ppath.cas.psu.edu/extension.html
Puerto Rico: Department of Agriculture. http://www.agricultura.gobierno.pr
Rhode Island: University of Rhode Island, Kingston, RI 02881. httw://www.uri.edu/ce/ceec/plantclinic.html
South Carolina: Clemson University, Clemson, SC 29634. http://www.clemson.edu/agsrvlb
South Dakota: South Dakota State University, Brookings, SD 57007. http://plantsci.sdstate.edu/planthealth/subpage.cfm?ID=12
Tennessee: University of Tennessee, Nashville, TN 37211. http://soilplantandpest.utk.edu/
Texas: Texas A & M University, College Station, TX 77845. http://plantdiseaselab.tamu.edu/
Utah: Utah State University, Logan, UT 84322. http://utahpests.usu.edu
Vermont: University of Vermont, Burlington, VT 05405. http://pss.uvm.edu/pd/pdc/
Virgin Islands: Virgin Islands Extension Service, Kingshill, St. Croix, VI 00850. http://rps.uvi.edu/CES/index.html
Virginia: Virginia Polytechnic Institute, Blacksburg, VA 24061. http://www.ppws.vt.edu/~clinic/
Washington: WSU Research and Extension Center, Puyallup, WA 98371. http://www.puyallup.wsu.edu/plantclinic/index.html
West Virginia: West Virginia University Extension Service, Morgantown, WV 26506. http://www.mastergardener2008.com/

Wisconsin: University of Wisconsin, Madison, WI 53706. http://pddc.wisc.edu/, http://www.entomology.wisc.edu/entodiag.html

Wyoming: University of Wyoming Cooperative Extension Service, Laramie, WY 82071. http://ces.uwyo.edu/

Ontario: Pest Diagnostic Clinic, University of Guelph, Ontario, Canada, N1H 8J7. http://www.labservices.uoguelph.ca/units/pdc/

Glossary

Acervulus, pl. *Acervuli*. A "little heap," an erumpent, cushionlike mass of hyphae bearing conidiophores and conidia, sometimes with setae; characteristic of the Melanconiales (Fig. 2.5).

Acicular. Needlelike.

Aeciospore. Rust spore formed in an aecium.

Aecium, pl. *Aecia*. A cluster-cup, or cuplike fruiting sorus in the rusts (Fig. 3.55).

Aerobic. Living or active only in the presence of oxygen.

Amoeboid. Not having a cell wall and changing in form like an amoeba.

Allantoid. Sausage-shaped.

Alternate Host. One or other of the two unlike hosts of a heteroecious rust.

Anamorph. State of life-cycle in which asexual spores, or none, are produced.

Annulus. A ring; ringlike partial veil around stipe in the mushrooms.

Antheridium, pl. *Antheridia*. Male sex organ in the fungi.

Anthracnose. A disease with limited necrotic lesions, caused by a fungus producing nonsexual spores in acervuli (Fig. 3.1).

Antibiotic. Damaging to life; especially a substance produced by one microorganism to destroy others.

Apothecium, pl. *Apothecia*. The cup- or saucer-like ascus-bearing fruiting body; in the Discomycete section of the Ascomycetes (Figs. 2.3, 3.53).

Appressorium. A swelling on a fungus germ tube for attachment to host in early stage of infection; found especially in anthracnose fungi and rusts.

Ascocarp, or *Ascoma*. Any structure producing asci, as an apothecium, perithecium.

Ascomycetes. One of the three main groups of the fungi, bearing sexual spores in asci.

Ascospore. Produced in ascus by free cell formation.

Ascus, pl. *Asci*. Saclike, usually clavate cell containing ascospores, typically eight (Fig. 2.3).

Aseptate. Without cross-walls.
Asexual. Vegetative, having no sex organs or sex spores; the imperfect stage of a fungus.
Autoecious. Completing life cycle on one host; term used in rusts.

Bacteria. Microscopic one-celled organisms increasing by fission.
Bactericide. Substance causing death of bacteria.
Basidiomycetes. Class 3 in the Fungi, characterized by septate mycelium, sometimes with clamp-connections, and sexual spores on basidia (Fig. 2.4).
Basidiospore. Spore produced on a basidium.
Basidium, pl. *Basidia*. Club-shaped structure, which, after fusion of two nuclei, produces four basidiospores (Fig. 2.4).
Binucleate. Having two nuclei.
Blight. A disease with sudden, severe leaf damage and often with general killing of flowers and stems.
Blotch. A blot or spot, usually superficial.
Breaking, of a virus. Loss of flower color in a variegated pattern, especially in tulips.

Canker. A lesion on a stem; a plant disease with sharply limited necrosis of the cortical tissue (Figs. 3.16, 3.17, 3.18).
Carrier. Infected plant showing no marked symptoms but source of infection for other plants.
Catenulate. In chains, or in an end-to-end series.
Cerebroid. With brainlike convolutions or folds.
Chemotherapy. Treatment of internal disease by chemical agents that have a toxic effect on the microorganism without injuring the plant.
Chlamydospore. Thick-walled, asexual resting spore formed by the rounding up of any mycelial cell (Fig. 3.46); also used for smut spores.
Chlorosis. Yellowing of normally green tissue due to partial failure of chlorophyll to develop; often due to unavailability of iron (Fig. 3.37).
Cilium, pl. *Cilia*. Hairlike swimming organ on bacteria or zoospores.
Cirrhus, pl. *Cirrhi*. A tendril or horn of forced-out spores.
Clamp-connections. Outgrowths of hyphae which form bridges around septa, thus connecting two cells; in Basidiomycetes (Fig. 2.4).
Clavate. Club-shaped.

Cleistothecium, pl. *Cleistothecia*. A perithecium without a special opening; in powdery mildews (Fig. 3.42).
Coalesce. Growing together into one body or spot.
Coenocytic. Multinucleate; mycelia having no cell walls.
Columella. Sterile central axis in a mature fruiting body (Fig. 2.2).
Concentric. One circle within another with a common center.
Conidiophore. Simple or branched hyphae on which conidia are produced.
Conidium. pl. *Conidia*. Any asexual spore except sporangiospore or chlamydospore.
Conk. Term used in forestry for sporophores of Polyporaceae on trees.
Control. Prevention of, or reduction of loss from, plant disease.
Coremium, pl. *Coremia*. Synnema, a cluster of erect hyphae bearing conidia (Fig. 2.5).
Coriaceous. Like leather in texture.
Culturing. Artificial propagation of organisms on nutrient media or living plants.
Cystidium, pl. Cystidia. Sterile, often swollen cell projecting from hymenium in Basidiomycetes.

Damping-off. Seed decay in soil, or seedling blight.
Decumbent. Resting on substratum with ends turned up.
Decurrent. Running down the stipe or stem.
Diagnosis. Identification of nature and cause of a disease.
Dieback. Progressive death of branches or shoots beginning at tips.
Defoliate. To strip or become stripped of leaves.
Dichotomous. Branching, frequently successive, into two more or less equal arms.
Dimidiate. Having one half smaller than the other; of a perithecium, having outer wall covering only top half.
Discomycetes. The cup fungi, a subclass of Ascomycetes; with apothecia.
Disease. A condition in which use or structure of any part of the living organism is not normal.
Disinfection. Freeing a diseased plant, organ, or tissue from infection.
Disinfestation. Killing or inactivating disease organisms before they can cause infection; on surface of seed or plant part, or in soil.
Dissemination. Transport of inoculum from a diseased to a healthy plant.
Disjunctor. Cell or projection connecting spores of a chain.
Duster. Apparatus for applying fungicides in dry form.

Echinulate. Having small, pointed spines; used of spores.
Endoconidium, pl. *Endoconidia*. Conidium formed within a hypha.
Enphytotic. A plant disease causing constant damage from year to year.
Epiphytotic. Sudden and destructive development of a plant disease over an extensive area, an epidemic.
Eradicant Fungicide. One that destroys a fungus at its source.
Eradication. Control of disease by eliminating the pathogen after it is already established.
Erumpent. Breaking through surface of substratum.
Excentric. Off center.
Exclusion. Control of disease by preventing its introduction into disease-free areas.
Exudate. Liquid discharge from diseased tissues.

Fasciation. Joining side by side; a plant disease with flattened and sometimes curved shoots.
Fascicle. A small bundle or cluster.
Filiform. Threadlike.
Fimbriate. Fringed, or toothed.
Flag. A branch with dead leaves on an otherwise green tree.
Flagellum, pl. *Flagella*. Whiplike organ on a motile cell; cilium.
Fruiting Body. Fungus structure containing or bearing spores; mushroom, pycnidium, perithecium, apothecium, etc.
Fumigant. A volatile disinfectant, destroying organisms by vapor.
Fungicide. Chemical or physical agent that kills or inhibits fungi.
Fungi Imperfecti. Fungi that have not been connected with the perfect or sexual stage; most are imperfect states of Ascomycetes.
Fungistatic. An agent preventing development of fungi without killing them.
Fungus, pl. *Fungi*. An organism with no chlorophyll, reproducing by sexual or asexual spores, usually with mycelium with well-marked nuclei.
Fusiform. Spindle-like, narrowing toward the ends.
Fusoid. Somewhat fusiform.

Gall. Outgrowth or swelling, often more or less spherical, of unorganized plant cells as result of attack by bacteria, fungi, or other organisms.
Gametangium. Gamete mother cell.
Gamete. A sex cell, especially one formed in a gametangium.

Germ Tube. Hypha produced by a germinated fungus spore.
Gill. Lamella or hymenium-covered plate on underside of cap of a mushroom.
Girdle. A canker that surrounds stem, completely cutting off water supply and thus causing death; girdling roots also cause death.
Glabrous. Smooth.
Gleba. Sporulating tissue in an angiocarpous fruit body.
Globose. Almost spherical.
Gram-negative, Gram-positive. Not being stained, and being stained, by the Gram stain used in classifying bacteria.

Haustorium, pl. *Haustoria*. Special hyphal branch extended into living cell for purpose of absorbing food (Fig. 3.41).
Heteroecious. Undergoing different parasitic stages on two unlike hosts, as in the rusts.
Heterothallic. Of a fungus, sexes separate in different mycelia.
Holocarpic. Having all the thallus used for a fruiting body.
Homothallic. Both sexes present in same mycelium.
Host. Any plant attacked by a parasite.
Hyaline. Colorless, or nearly transparent.
Hymenium. Spore-bearing layer of a fungus fruiting body.
Hyperplastic. Term applied to a disease producing an abnormally large number of cells.
Hypha, pl. *Hyphae*. Single thread of a fungus mycelium.
Hypoplastic. Term applied to a disease with subnormal cell production.
Hyphopodium, pl. *Hyphopodia*. More or less lobed appendage to a hypha.
Hysterothecium. Oblong or linear perithecium, sometimes considered an apothecium, opening by a cleft.

Immune. Exempt from disease; having qualities that do not permit infection.
Immunization. Process of increasing the resistance of a living organism.
Imperfect Fungus. One lacking any sexual reproductive state.
Imperfect State. State of life-cycle in which asexual spores, or none, are produced. See Anamorph.
Incubation Period. Time between inoculation and development of symptoms that can be seen.
Indehiscent. Of fruit bodies, not opening, or with no special method.
Infection. Process of beginning or producing disease.

Infection Court. Place where an infection may take place, as leaf, fruit, petal, etc.

Injury. Result of transient operation of an adverse factor, as an insect bite, or action of a chemical.

Innate. Bedded in, immersed.

Inoculation. Placing of inoculum in infection court.

Inoculum. Pathogen or its part, as spores, fragments of mycelium, etc., that can infect plants.

Inoperculate. Not opening by a lid.

Intercellular. Between cells.

Intracellular. Within cells.

*Intumescenc*e. Knoblike or pustulelike outgrowth of elongated cells on leaves, stems, etc., caused by environmental disturbances.

Lamella. Gill.

Lesion. Localized spot of diseased tissue.

Locule. A cavity, especially one in a stroma.

Macroconidia. Large conidia.

Macroscopic. Large enough to be seen with the naked eye.

Medulla. Loose layer of hyphae inside a thallus; body of a sclerotium.

Microconidia. Very small spores, now considered spermatia of a fungus also having larger conidia.

Micron. 1/1000 millimeter, unit used for measuring spores.

Microscopic. Too small to be seen except with the aid of a microscope; true of most of the fungus structures shown in line drawings in this book.

Mildew. Plant disease in which the pathogen is a growth on the surface.

Molds. Fungi with conspicuous mycelium or spore masses, often saprophytes.

Monoecious. Male and female reproductive organs in same individual; in rusts, all stages of life cycle on single species of plant.

Multinucleate. Several nuclei in same cell.

Mummy. Dried, shriveled fruit, result of disease.

Muriform. Having cross and longitudinal septa.

Mushroom. An agaric fruit body (Fig. 2.4).

Mycelium pl. *Mycelia*. Mass of fungus hyphae.

Mycelia Sterilia. Fungi Imperfecti where spores, except for chlamydospores, are not present.

Mycoplasmalike Organism (MLO). A walless prokaryotic plant pathogen which has a single-unit membrane. See Phytoplasma.
Mycorrhiza, pl. *Mycorrhizae*. Symbiotic, nonpathogenic association of fungi and roots.

Necrosis. Death of plant cells, usually resulting in tissue turning dark.
Necrotic. As an adjective, killing.
Nematicide. Chemical or physical agent killing nematodes.
Nematodes. Nemas, roundworms, eelworms, cause of some plant diseases.

Obligate Parasite. A parasite that can develop only in living tissues, with no saprophytic stage.
Obovate. Inversely ovate, narrowest at base.
Obtuse. Rounded or blunted, greater than a right angle.
Oogonium, pl. *Oogonia*. Female sex organ in the Oomycetes (Fig. 2.1).
Oomycetes. Subclass of the Phycomycetes, gametangia of unequal size.
Oospore. Resting spore formed in a fertilized oogonium.
Operculate. With a cover or lid, as in some asci.
Ostiole. Porelike mouth or openings in papilla or neck of a perithecium or pycnidium.

Papilla, pl. *Papillae*. Small, nipplelike projection.
Paraphysis, pl. *Paraphyses*. A sterile hyphal element in the hymenium, especially in the Ascomycetes, usually clavate or filiform.
Paraphysoids. Threads of hyphal tissue between asci, like delicate paraphyses but without free ends.
Parasite. An organism that lives on or in a second organism, usually causing disease in the latter.
Pathogen. Any organism or factor causing disease.
Pathogenic. Capable of causing disease.
Pedicel. Small stalk.
Perfect State. Stage of life-cycle in which spores are formed after nuclear fission. See Teleomorph.
Peridium. Wall or limiting membrane of a sporangium or other fruit body, or of a rust sorus.
Perithecium. Subglobose or flasklike ascocarp of the Pyrenomycetes (Fig. 2.3).

Phialide. A cell that develops one or more open ends from which a basipetal succession of conidia develops without an increase in length of the phialide itself.

Physiogenic Disease. Caused by unfavorable environmental factors.

Physiologic Races. Pathogens of same variety and species structurally the same but differing in physiological behavior, especially in ability to parasitize a given host.

Phytopathology. Plant pathology, science of plant disease.

Phytoplasma. A MLO that is pathogenic to plants.

Pileus. Hymenium-supporting part of a fruit body of a higher fungus; the cap of a mushroom.

Primary Infection. First infection by a pathogen after going through a resting or dormant period.

Prokaryotic. Organisms which lack a true nucleus; includes bacteria and mycoplasmalike organisms.

Promycelium. Basidium of rusts and smuts.

Pulvinate. Cushionlike in form.

Pycnidium, pl. *Pycnidia*. Flasklike fruiting body containing conidia.

Pycnium. Spermagonium in the rusts, the 0 stage, resembling a pycnidium (Fig. 3.55).

Resistance. Ability of a host plant to suppress or retard activity of a pathogen.

Resting Spore. A spore, often thick-walled, that can remain alive in a dormant condition for some time, later germinating and capable of initiating infection.

Resupinate. Flat on the substratum with hymenium on outer side.

Rhizoid. Rootlike structure (Fig. 2.2).

Rhizomorph. A cordlike strand of fungus hyphae.

Ring Spot. Disease symptoms characterized by yellowish or necrotic rings with green tissue inside the ring, as in virus diseases.

Roguing. Removal of undesired individual plants.

Rosette. Disease symptom with stems shortened to produce a bunchy growth habit.

Russet. Brownish roughened areas on skins of fruit, from abnormal production of cork caused by disease, insect, or spray injury.

Rust. A fungus, one of the Uredinales, causing a disease also known as rust.

Saprophyte. An organism that feeds on lifeless organic matter.

Scab. Crustlike disease lesion; or a disease in which scabs are prominent symptoms (Fig. 3.58).

Sclerotium, pl. *Sclerotia*. Resting mass of fungus tissue, often more or less spherical, normally having no spores in or on it (Figs. 3.51, 3.53).

Scorch. Burning of tissue, from infection or weather conditions.

Scutellum. Plate or shieldlike cover, as in Microthyriales.

Septate. Having cross-walls, septa.

Sessile. Having no stem.

Seta, pl. *Setae*. A stiff hair, or bristle, generally dark-colored.

Shothole. A disease symptom in which small round fragments drop out of leaves, making them look as if riddled by shot.

Sign. Any indication of disease other than reaction of the host plant – pores, mycelium, exudate, or fruiting bodies of the pathogen.

Slurry. Thick suspension of chemical; used for seed treatment.

Smut. A fungus of the Ustilaginales, characterized by sooty spore masses; the name also used for the disease caused by the smut.

Sooty Mold. Dark fungus growing in insect honeydew.

Sorus, pl. *Sori*. Fungus spore mass, especially of rusts and smuts; occasionally, a group of fruiting bodies.

Species. One sort of plant or animal; abbreviated as "sp." singular, and "spp." plural. A genus name followed by sp. means that the particular species is undetermined. Spp. following a genus name means that several species are grouped together without being named individually.

Spermagonium. Walled structure in which spermatia are produced, a pycnium.

Spermatium, pl. *Spermatia*, a sex cell (+ or −), a pycniospore.

Sporangiole. Small sporangium without a columella and with a small number of spores.

Sporangiophore. Hypha bearing a sporangium.

Sporangium. Organ producing nonsexual spores in a more or less spherical wall (Fig. 2.1).

Spore. A single- to many-celled reproductive body, in the fungi and lower plants, which can develop a new plant.

Sporidium, pl. *Sporidia*. Basidiospore of rusts and smuts.

Sporodochium, pl. *Sporodochia*. Cluster of conidiophores interwoven on a stroma or mass of hyphae (Fig. 2.5).

Sporophore. Spore-producing or supporting structure – fruit body; used especially in the Basidiomycetes (Fig. 3.49).

Sporulate. To produce spores.

Sprayer. Apparatus for applying chemicals in liquid form.

Sterigma, pl. *Sterigmata*. Projection for supporting a spore.

Stipe. A stalk. *Stipitate.* Stalked.

Strain. An organism or group of organisms differing in origin or minor aspects from other organisms of same species or variety.

Stroma, pl. *Stromata*. Mass of fungus hyphae often including host tissue containing or bearing spores.

Subiculum, Subicle. Netlike woolly or crustlike growth of mycelium under fruit bodies.

Substrate. The substance or object on which a saprophytic organism lives and from which it gets nourishment.

Suscept. A living organism attacked by, or susceptible to, a given disease or pathogen; in many cases a more precise term than host but less familiar.

Susceptible. Unresistant, permitting the attack of a pathogen.

Swarmspore. Zoospore.

Synnema, pl. *Synnemata*. Groups of hyphae sometimes joined together, generally upright and producing spores; coremium.

Systemic. Term applied to disease in which single infection leads to general spread of the pathogen throughout the plant body; or to a chemical that acts through the vascular system.

Teleomorph. State of life-cycle in which spores are formed after nuclear fission.

Teliospore. Winter or resting form of rust spore, from which basidium is produced (Figs. 3.54, 3.55, 3.56).

Telium. Sorus producing teliospores.

Thallophyte. One of the simpler plants, belonging to the algae, bacteria, fungi, slime molds, or lichens.

Thallus. Vegetative body of a thallophyte.

Tolerant. Capable of sustaining disease without serious injury or crop loss.

Toxin. Poison formed by an organism.

Tylosis pl. *Tyloses*. Cell outgrowth into cavity of xylem vessel, plugging it.

Urediospore. Summer spore of rusts; one-celled, verrucose (Fig. 3.54).

Uredium. Sorus producing urediospores.

Valsoid. Having groups of perithecia with beaks pointing inward, or even parallel with surface, as in valsa.

Vector. An agent, insect, man, etc., transmitting disease.

Vein-banding. Symptom of virus disease in which regions along veins are darker green than the tissue between veins.

Verrucose. With small rounded processes or warts.

Viroid. The smallest known viruslike infectious agent having no protein coat and only a small amount of nucleic acid.

Virulent. Highly pathogenic; with strong capacity for causing disease.

Viruliferous. Virus-carrying; term applied particularly to virus-laden insects.

Virus. An obligate parasite capable of multiplying in certain hosts, ultramicroscopic, recognizable by the effects produced in infected hosts. Has nucleic acid with protein coat.

Wilt. Loss of freshness or drooping of plants due to inadequate water supply or excessive transpiration; a vascular disease interfering with utilization of water.

Witches' Broom. Disease symptom with abnormal brushlike development of many weak shoots.

Yellows. Term applied to disease in which yellowing or chlorosis is a principal symptom.

Zoospore. A swimming spore, swarmspore, capable of independent movement (Fig. 2.1).

Zygomycetes. Subclass of the Phycomycetes, characterized by gametes of equal size.

Zygospore. Resting spore formed from the union of similar gametes (Fig. 2.2).

Selected Bibliography

In the preparation of *Westcott's Plant Disease Handbook* references have been reviewed that cover a century of scientific reporting. An attempt has been made also to keep abreast of current literature. To cite all of the individual articles that have been helpful would fill another book. The bibliography presented here is a selected small sampling of the field surveyed, with emphasis on sources consulted in making nomenclatural decisions.

Periodicals that are regularly reviewed include *Plant Disease*, *Phytopathology, Review of Applied Mycology, Journal of Economic Entomology, A.I.B.S. Bulletin* (Agricultural Institute of Biological Sciences), *Biological Abstracts, Agricultural Chemicals, NAC News* (National Agricultural Chemicals Association), *Arborist's News, Proceedings of the National Shade Tree Conference, American Fruit Grower, American Vegetable Grower, Farm Journal, The Garden Journal* (New York Botanical Garden), *Plants and Gardens* (BrookIyn Botanic Garden), *The National Gardener* (National Council of State Garden Clubs), publications of many of the state garden clubs, most of the popular garden magazines, yearbooks and magazines of several single plant societies. In addition, there are numerous bulletins, circulars, and spray schedules from state experiment stations.

The following references provide coverage in depth of the current taxonomy of the major types of plant pathogens.

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Index

Abelia 703
  Latent Tymovirus 602
  Leaf Spot 310
Abelia Latent 703
Abutilon
  (Flowering Maple, Indian Mallow, Velvet Leaf) 703
  Infectious Variegation 602, 704, 931
  Mosaic 1070
  Mosaic Bigeminivirus 602
  Yellows 704
Acacia 704
  (Koa Tree) 704
Acalypha
  (Copper-Leaf) 705
  Downy Mildew 280
Acantharia echinata 980
Acanthopanax (Five-Leaf Aralia) 705
Acanthorhynchus vaccinii 455, 817
Acanthostigma parasiticum 860
Acanthus 705
Achimenes sp. 705
Achrotelium 535
  lucumae 535, 944
Acid Scab 575
Acidity, Excess 414
Acidovorax
  avenae 112, 813, 959, 1087, 1133
  avenae (syn. Pseudomonas avenae) 924
  avenae subsp. avenae 1008
  avenae subsp. citrulli 112
  cattleyae 112
Acremonium 456
  (Cephalosporium) 681
  crotocinigenum 1101
  diospyri 681
  typhinum 889
Acremonium sp. 456, 960, 1133
Acroconidiella escholtziae 333
Acroptilon repens (Knapweed, Russian) 705
Acrospermaceae 54
Actinomeris (Yellow Ironweed) 705
Actinomycosis 575
Actinopelte dryina 303, 731, 794, 850, 953, 980, 1099, 1118
Actinothyrium 303
  gloeosporioides 303, 1064
Adelopus
  gäumannii 375, 838
  Needle Cast 375
  nudus 860
Adoxa (Musk-Root) 706
Aecidium 535
  aesculi 910
  anograe 982
  arcularium 761
  avocense 535
  batesii 1056
  betheli 1134
  campanulastri 776
  cannonii 864, 982
  columbiense 894
  conspersum 536
  cyrillae 826

hesleri 941
insulum 810
lycii 946
mexicanum 802
mirabilis 864
modestum 951
physalidis 890
plenum 1037
renatum 963
residuum 757
rubromaculans 536, 1126
subsimulans 1059
tracyanum 840
triostei 910
Aecidium sp. 908, 939
Aegopodium (Bishop's Weed) 706
Aeschynomene (Northern Joint-Vetch) 706
Aesehynanthus 706
African Daisy (Arctotis) (Gerbera jamesonii) 706
African Violet (Saintpaulia) 707
Agapanthus (African-Lily) 707
Agaricaceae 61
Agastache (Giant-Hyssop) 707
Ageratum 708
Aglaospora anomala 942
Agrimony (Agrimonia) 708
Agrobacterium
pseudotsugae 837
Radiobacter 26
rhizogenes 98, 718, 730, 753, 815, 832, 842, 905–907, 972, 1000, 1007, 1041, 1045, 1051, 1075, 1083, 1110
rubi 98, 753, 832, 1045
tumefaciens 98, 711, 718, 723, 726, 733, 734, 736, 748, 750, 753, 756, 769, 770, 774, 775, 780, 784, 786, 790, 791, 800, 803, 806, 808, 825, 826, 829, 832, 835, 842, 849, 850, 858, 859, 864, 870, 882, 895, 901, 902, 907, 908, 911, 916, 922–924, 926, 936, 940, 953, 955, 962, 969, 976, 979, 997, 1000, 1004, 1007, 1009, 1013, 1016, 1026, 1028, 1030, 1038, 1041, 1042, 1045, 1048, 1050, 1051, 1055, 1056, 1073, 1074, 1094, 1100, 1108, 1110, 1119, 1125, 1130, 1135, 1136, 1139, 1141, color plate 7
Agropyron Mosaic 889
Ailanthus (Tree-of-Heaven) 708
Air Pollution 414, 1043
Air Pollution Injury 800, 1015
Akee Tree (Blighia sapida) 709
Albuginaceae 49
Albugo
(Cystopus) 679
bliti 679, 713, 749, 876
candida 679, 725, 730, 768, 777, 796, 839, 901, 911, 1013, 1043, 1120, 1129, 1132, 1138
froelichiae 866
ipomoeae-panduratae 680, 826, 922, 968, 969, 1102
occidentalis 680, 1082
platensis 680, 710, 864, 1081, 1121
portulacae 680, 1033
tragopogonis 680, 706, 729, 789, 802, 852, 957, 1061, 1067, 1098, 1107
trianthemi 1069
Albugo sp. 934
Albutilon
Yellows Closterovirus 603
Alder
(Alnus) 709
Powdery Mildew 442
Aleurodiscus 224
acerina 224
acerinus 939, 953, 980
aceris 794
amorphus 224, 726, 860, 930, 1020, 1083
candidus 902, 980
griseo-canus 939, 980
nivosus 726, 790, 925

oakesii 224, 751, 909, 980
spinulosus 930
werii 930
Aleurodiscus spp. 731, 838, 908
Alfalfa
Dwarf 884
Mosaic 713, 745, 783, 808, 990, 996, 1029, 1035, 1095, 1098, 1121
Mosaic Alfamovirus 603
Alfamovirus 70
Algal Spot 308
Algerian Navel Orange 805
Alkali Injury 415
Alkalinity 415
Allamanda 710
Alliaria (Garlic Mustard) 710
Alligatorweed
Stunting Closterovirus 603
Allionia (Trailing Four-O'Clock) 710
Allium altaicum 986
Allium pskemense 986
Allium vavilovii 986
Allspice
(Pimenta) 710
Almond
(Prunus amygdalus) 711
Bud Failure 603, 711
Calico 603, 711
Flowering (Prunus triloba) 712
Scab 571
Aloe 712
Alpakesa yuccifolia 344
Alphacryptovirus 70
Alstroemeria 712
mosaic 712
Mosaic Potyvirus and Alstromeria Streak Potyvirus 603
streak 712
Alternanthera 712
Mosaic 862, 969, 1071
Mosaic Potexvirus 603
Alternaria 150, 218, 303, 456, 1048
alternata 150, 303, 456, 711, 771, 896, 945, 978, 999, 1112, 1131, 1144
angustiovoidea 303, 1085
arborescens 711, 896, 1130
Blight 151–153
brassicae 303, 767, 796, 911, 973, 1043, 1119
brassicae var. microspora 1052
brassicicola 303, 304, 767, 1108
cassiae 150, 783, 819
catalpae 304, 785
chrysanthemi 304, 802, 1107
citri 304, 456, 723, 803, 804, 891, 929, 991
citri var. cerasi 792
consortiale 821
crassa 828
cucumerina 151, 821, 960, 1086, 1133
dauci 151, 782, 996
dauci f. sp. solani 872
dianthi 780, 833, 946
dianthicola 152
fasciculata 304, 1054
helianthi 152, 1097
iridicola 918
lancipes 1037
leucanthemi 304
longipes 304, 978
mali 456, 721, 1041
nelumbii 944
oleracea 304, 796, 906, 911, 1043, 1066, 1119
oleraceae 767
panax 152, 304, 725, 834, 874, 1065, 1119
passiflorae 304, 998
polypodii 304, 857
porri 218, 985, 1069
radicina 456, 782, 1086
raphani 305, 1043, 1091, 1119
Rot 456

saponariae 1076
scorzonerae 214
sesami 1068
solani 152, 456, 796, 841, 890, 923, 1033, 1110
sonchi 305
spinaciae 1082
stemphylioides 992
tagetica 153, 305, 956
tennis 985
tenuis 305, 720, 737, 768, 782, 805, 821, 859, 901, 948, 982, 1018, 1061, 1086, 1104, 1119, 1143
tenuissima 153, 305, 711, 756, 896, 985, 1024, 1131
tomato 305, 1112
violae 995, 1127
zinniae 153, 456, 708, 1097, 1144
Alternaria Blight 151
Alternaria sp. 305, 457, 703, 705, 721, 723, 725, 726, 732, 734, 737, 748, 754, 756, 757, 759, 771, 773, 774, 777, 784, 787, 792, 794, 800, 808, 809, 812, 818, 823, 826, 846, 852, 859, 864, 871, 880, 884, 911, 927–929, 934, 939, 942, 945, 950, 953, 957, 964, 965, 968, 970, 983, 991, 993, 997, 999, 1003, 1006, 1009, 1014, 1027, 1030, 1038, 1046, 1050, 1052, 1056, 1065, 1075, 1078, 1079, 1082, 1087, 1090, 1100, 1101, 1112, 1115, 1120, 1126, 1131, 1132, 1134, 1138, 1142
Alternaria spp. 744, 800, 875, 905, 960, 1012, 1058
Alternariosis 153
Aluminum Toxicity 415
Alyssum
(Goldentuft, Yellowtuft) 712
Amaranthus (Love-Lies-Bleeding, Princes-Feather, Joseph-Coat, Spiny Amaranth) 713
Amaryllis
(includes Hippeastrum) 713
Wild (Nothoscordum bivalve; N. inodorum) 713
Amelanchier (Serviceberry, Juneberry) 714
American Dagger Nematode 411
American Gooseberry Mildew 451
American Hornbean Leaf Curl 295
Amerosporium 305
trichellum 305, 920
Amorpha (Leadplant, Indigobush) 714
Ampelopsis
(A. cordata and other species) 715
Amphiporthe
aculeans 233
castanae 233
Amphisphaeriaceae 55
Amphobotrys 225, 457
ricini 225
Amphobotrys ricini 457, 1029, 1086, 1107
Amsonia 715
Anabaena cycadeae 1143
Anabaena cycadearum 824
Anaphalis (Pearl Everlasting) 715
Anchusa (Buglos, Alkanet) 715
Andromeda (Bog-Rosemary) 715
Aneilema Mosaic 811
Anemone
(Cultivated forms, Japanese) 716
(Native Species) 716
Angelica 717
Angelonia
Flower 1017
Flower Break Carmovirus 1123, 1124
Angelonia (Angelonia angustifolia) 717
Angiospora 536
Anguina 385
agrostis 385, 887
balsamophila 385, 739
graminis 385
tritici 386
Angular
Leaf Spot 112, 115, 117, 124, 172, 197, 198, 334, 340

Anise
(Pimpinella anisum) 717
Anise-Tree
(Illicium floridanum) 717
Anisogramma anomala 225, 895
Annellophora 305
phoenicis 305, 991
Anoda 717
Anther Smut 591
Anthracnose 87–91, 96, 327
Anthriscus (Chervil) 718
Anthurium 718
Antidesma (Chinese-Laurel) 718
Aphanomyces 457
cladogamus 457, 995, 1082, 1112
cochlioides 457, 749
euteiches 457, 787, 999, 1084, 1101
eutiches 745, 959
raphani 458, 768, 796, 906, 973, 1043, 1066
Aphanomyces sp. 1012
Aphelandra (Zebra plant) 718
Aphelenchoides 386
besseyi 386, 1056, 1093
fragariae 386, 716, 724, 738, 750, 759, 771, 809, 824, 845, 854–857, 901, 911, 929, 937, 946, 968, 974, 1016, 1021, 1032, 1038, 1058, 1073, 1093
parietinus 387, 918, 964
ritzemabosi 387, 389, 707, 716, 735, 800, 826, 881, 945, 964, 1010, 1067, 1144, color plates 11, 12
subtenuis 389, 974
tagetae 956
Aphelenchoides sp. 776, 818, 837, 871, 914, 1003
Aphelenchoides spp. 1053
Aphelenchus
agricola 716
avenae 974
Apical Leaf Roll 1035
Apiognomonia 84
errabunda 84
tiliae 84
veneta 84
Apioplagiostoma populi 1031
Apioporthe 225
anomala 225, 895
apiospora 225, 844
Apiosporina 134, 139
collinsii 139, 714
morbosa 134
Apiosporium
pinophilum 924
Aplopsora 536
nyssae 536, 1119
Aposphaeria
fuscomaculans 261
Apostrasseria
(Ceuthospora) 466
lunata 466
Appendiculella
araliae 141
calostroma 141
perseae 141
Apple
(Malus sylvestris) 718
Blotch 221
Canker 266, 267
Chlorotic Leaf Spot 722, 1006
Chlorotic Leaf Spot Trichovirus 604
Dapple 604
Green Mottle 604
Mosaic 722, 896, 1006, 1054, 1094
Mosaic Ilarvirus 604
Rot 114
Scab 576
Stem Grooving Capillovirus 604
Stem Growing 722
Stem-Pitting 604
Apple-Of-Peru
(Nicandra) 722
Apricot
(Prunus armeniaca) 723
Gummosis 605, 724
Pucker Leaf 724
Ring Pox 605, 724, 1027

Aquathanatephorus pendulus 1132
Aquatic
  Plants (Caboriaba sp., Limnophila sp., Replis diandra, and Potamogeton sp.) 724
Arabidopsis 725
Arabis
  (Rock-Cress) 724
  Mosaic 725, 912
  Mosaic Nepovirus 605
Aralia
  Hercules Club (Aralia spinosa) 725
  Ming (Polyscias) 725
  Sarsaparilla, American Spikenard (Aralia hispida, A. nudicaulis, A. racemosa) 725
  Scab 600
  Udo (Aralia cordata) 726
Araucaria
  (Monkey-Puzzle, Norfolk-Island-Pine) 726
  Branch Blight 169, 213
Arborvitae
  (Thuja) 726
  Blight 165
  Leaf Blight 174
Arceuthobium
  (Dwarf Mistletoe) 370
  abietinum 898
  americanum 370, 861, 1020
  campylopodium 861, 898, 1084
  campylopodum 370, 930, 1020
  cyanocarpum 370, 898, 1020
  douglasii 370, 838, 861
  duglasiana 1020
  gilli 1020
  herrarie 1020
  hondurense 1020
  laricis 370, 861, 898
  occidentale 370, 1020
  pusillum 371, 930, 1084
  tsugense 371, 898
  vaginatum 1020, 1084
  vaginatum subsp. cryptopodum 371, 1020
  vaginatum subsp. vaginatum 1020
Arctotis 727
Ardisia 727
Argyreia 727
Aristastoma 306
  oeconomicum 306, 744
Aristastoma sp. 306, 831
Arizona Purple Top Wilt 133
Armeria (Sea-Pink, Thrift) 727
Armillaria 458
  (Clitocybe) 467
  gallsia 828
  mellae 730
  mellea 458, 700, 704, 708, 710–713, 721, 724, 726, 732, 737, 738, 741, 748, 750, 752, 754, 758, 760, 762, 770, 773, 774, 777, 778, 780, 784–786, 790, 791, 793, 794, 797, 804, 815, 817, 818, 823, 826, 831, 832, 836–838, 845, 850, 859, 861, 866, 871, 875, 881, 884, 892, 895, 896, 898, 903, 907–910, 914–916, 921, 930, 931, 933, 937, 942, 944, 945, 954, 963, 970–972, 975, 977, 981, 984, 992, 998, 1001, 1006, 1008, 1010, 1014, 1018, 1021, 1025, 1027, 1031, 1035, 1039, 1040, 1046, 1049–1051, 1053, 1064, 1068, 1084, 1094, 1096, 1097, 1100, 1117, 1131, 1134, 1137, 1140, 1142
  tabescens 467, 992
Armillariella
  mellea 925
Arnica 727
Arrow-Arum (Peltandra) 728
Arrowhead (Sagittaria) 728
Arrowroot (Maranta) 728
Arsenical Injury 416, 723
Artemisia 1106
Artemisia (Wormwood) 728
Arthrocladiella mongeotii 946

Arthuriomyces
(Gymnoconia) 545
peckianus 545
Artichoke
(Globe) Curly Dwarf Potexvirus 605
Curly Dwarf 729
Globe (Cynara scolymus) 729
Jerusalem (Helianthus tuberosus) 729
Latent 729
Latent Potyvirus 605
Articularia quercina var. minor 982
Artillery Plant, Aluminum Plant (Pilea) 729
Artocarpus (Breadfruit) 730
Arugula (Eruca sativa) 730
Arundo (Giant Reed) 730
Aschochyta
brachypodii 306
Ascocalyx abietina 262
Ascochyta 153, 306, 460
abelmoschi 306, 983, 1055
achlyicola 1122
actaeae 740, 801
agropyrina 886
althaeina 306, 905
aquilegiae 810, 829
armoraciae 306
asparagina 153, 732
aspidistrae 306, 733
asteris 306, 734
Blight 153, 307
boerhaaviae 1081
bohemica 776
boltshauseri 306, 744, 746
brachypodii 758, 916
capsici 1011
caricae 859
cassandrae 790
cephalanthi 766
cheiranthi 306
chrysanthemi 153, 800
clematidina 306, 806
clematidina f. sp. thalictri 958
compositarum 307, 734, 851, 880, 1071, 1097
confusa 1072
cornicola 307, 836
cycadina 824
cypripedii 307
desmazieri 886
dianthi 833
elymi 886
fabae f. sp. spiricia 153
fabae f. sp. vicia 1125
fremontiae 865
garrettiana 989
graminae 886
graminicola 886
hanseni 948
hordei 886
hydrangeae 913
hydrophylli 914
infuscans 1044
iridis 918
juglandis 307, 1130
lathyri 1100
ledi 932
leonuri 969
lophanthi 707, 1132
lycopersici 307, 841, 923, 1034, 1110
majalis 938
marginata 725
negundinis 759
nepetae 785
oxybaphi 710, 1121
paulowniae 998
penstemonis 1009
petuniae 1015
phaseolorum 307, 744
philadelphi 966
phlogis var. phlogina 1016
piniperda 153, 1083
pinodella 153, 999
pinodes 153, 460
pirina 798
pisi 153, 307, 999
plumbaginicola 1090

primulae 1038
radiei 795
Ray Blight 153, 154
rhei 1050
rhodotypi 923
salicis 1137
sambucina 843
silenes 1070
sorghi 886
symphoricarpophila 1075
thaspii 1144
treleasei 919
utahensis 886
veratrina 1123
verbenae 1124
versicolor 874
violae 1127
violicola 1127
wisconsina 843
Ascochyta sp. 732, 753, 821, 871, 896, 945, 1003, 1007, 1043, 1086, 1092, 1100, 1115
Ascocorticiaceae 57
Ascomycota 51
Ascospora 225
ruborum 225, 754, 832, 1045
Ash
(Fraxinus) 730
Canker 241
Leaf Spot 337, 338, 341, 342
Moraine (Fraxinus holotriocha) 732
Ring Spot 731
Ring Spot = Arabis Mosaic Nepovirus 605
Rust 565
Witches' Broom 605, 730
Yellows 130, 937
Ashy
Stem Blight 185, 211, 493
Asparagus
(Asparagus officinalis) 732
1 Potyvirus 606
2 Ilarvirus 606
Fern (Asparagus plumosus) 732
Florists' Smilax (Asparagus asparagoides) 733
Rust 560
Sprenger (Asparagus sprengeri) 733
Asparagus Tree Fern (Asparagus virgatus) 733
Aspergillus 461, 1079
alliaceus 461, 769, 770
chevalieri 1008
fischeri 871
flavus 945
foetidus 803
fumigatus 461, 749
niger 461, 721, 783, 859, 883, 884, 945, 986, 992, 1001, 1004, 1030, 1035, 1063
niger var. floridanus 461, 839
Aspergillus sp. 1006
Aspergillus spp. 461, 804, 975, 1102, 1112, 1116
Asperisporium caricae 995
Aspidistra 733
Leaf Spot 306
Aster
China (Callistephus) 733
Chlorotic Stunt 735
Chlorotic Stunt Carlavirus 606
Mosaic 735
Perennial (Aster spp.) 734
Ring Spot 606, 1012
Wilt 688
Yellows 130, 713, 716, 733, 751, 765, 771, 773, 776, 778, 780, 782, 788, 796, 800, 801, 805, 812, 815, 826, 827, 834, 840, 846–848, 867, 875, 877, 879, 892, 893, 897, 933, 939, 955, 973, 977, 984, 996, 997, 1003, 1015, 1016, 1033, 1040, 1056, 1061, 1065, 1069, 1081, 1086, 1091, 1092, 1095, 1098, 1108, 1110, 1126, 1144
Yellows Phytoplasma 767
Yellows, Clover Proliferation 985
Asterella paupercula 922

Asteria celastri 753
Asteridiella manca 141
Asteridium lepidigenum 140
Asterina 139
  anomala 140, 772
  asterophora 831
  bignoniae 751
  caricarum 995
  clavuligera 715
  conglobata 747
  cupressina 924
  delitescens 140, 1047
  diplodioides 935
  diplopoides 140
  discoidea 831
  gaultheriae 140, 747
  ilicis 903, 917
  lepidigena 140, 947
  lepidigenoides 779
  orbicularis 140
  pelliculosa 903
  phoradendricola 965
  purpurea 831
  radians 779
  sabalicola 994
  somatophora 781
Asterina orbicularis 903
Asterina sp. 1100
Asterinella 140
  puiggarii 140, 850
Asternia
  oleina 984
Asteroma 308
  fraserae 811
  garretianum 308, 1038
  inconspicuum 327
  solidaginis 308, 880
  tenerrimum 308
  tenerrimum var. erythronii 849
Asteromella
  (Stictochlorella) 308
  andrewsii 870
  lupini 308
Asterostomella saccardoi 349
Astilbe 735
Astragalus 735
Athelia rolfsii 190
Atropellis 225
  apiculata 225
  arizonica 225, 1019
  pinicola 226, 1019
  piniphila 226, 1019
  tingens 226, 1019
Atylenchus decalineatus 817
Aubrietta 735
Aucuba
  (Gold-Dust Tree) 735
  Leaf Spot 345, 349
Auerswaldia sp. 993
Aureobasidium 286
  pullulans 286, 721
Aureolaria
  grandiflora var. serrata 925
Auriculariaceae 60
Autumn Crocus (Colchicum) 736
Avocado
  (Persea americana) 736
  3 Alphacryptovirus 606, 737
  Blotch 218, 219
  Root Rot 509
  Scab 601
  Sun Blotch 737
  Sun Blotch Viroid 606
Awl Nematode 393
Axillary Bud Proliferation 1143
Azalea
  (Rhododendron) 737
  Anthracnose 89
  Flower Spot 188
  Leaf Gall 290
  Leaf Scorch 300
Azara 738
Azoxystrobin 16

Babiana 739
Bacillus
  polymyxa 1110
  subtilis 16, 883

Bacteria 1163
Bacterial
  Bean Blight 127, 129
  Blight 109, 114, 116–118, 122, 123, 125, 126, 128, 129
  Canker 101, 117, 120
  Crown Rot 108
  Knot 119
  Leaf Blight 112, 114
  Leaf Scorch 130
  Leaf Spot 112–118, 120, 123, 125, 126, 129
  Necrosis 106
  Pustule 124, 129
  Ring Disease 115, 121
  Ring Rot 102
  Rot 114
  Speck 120
  Spot 112, 113, 116, 121, 124, 127–130
  Stripe 112, 113
  Wilt 101, 104, 110–112, 114, 128, 130
  Wilt of Bean 103
  wilting 122
Bactericide 11
Bacteriosis 124, 128
Badhamia panicea 809
Badnavirus 71
Baeodromus 536
  californicus 536, 1067
  eupatorii 536
Balansia 154
  cyperi 154, 979
Bald Cypress (Taxodium) 739
Baldhead 416, 744, 1079
Baldwin Spot 720
Balm (Melissa) 739
Balsam
  Butt Rot 515, 517
  Fir Canker 224
Balsam-Apple, Balsam-Pear (Momordica) 739
Balsam-Root (Balsamorhiza) 739
Bamboo
  Mosaic 740
Bamboo (Bambusa, Phyllostachys) 739
Banana
  Dwarf (Musa nana) 740
  Shrub (Michelia figo) 740
Baneberry, Cohosh (Actaea) 740
Baptisia (False Indigo) 741
Barberry (Berberis) 741
Bark and Cone Spot 345
Bark Canker 229, 232, 239, 254, 255, 257
Bark Patch 224, 263, 264
Barley 741
  Yellow Dwarf 758, 814, 889, 916, 1104
  Yellow Dwarf Luteovirus 606
  Yellow Streak Mosaic 606
Barren-Strawberry (Waldsteinia) 742
Barrenwort (Epimedium) 742
Basal 489
  Canker 262
  Gall 292
  Rot 481, 482
  Stem Rot 107, 463
Basidiomycota 58
Basidiophora 275
  entospora 275, 734, 848, 879
Basil (Ocimum) 742
Bauhinia (Orchid-Tree, Mountain Ebony) 742
Bayberry (Myrica carolinensis) 742
Bayberry Yellows 607, 743
Bean
  Adzuki (Phaseolus angularis) 743
  Anthracnose 88, 94
  Asparagus, Yardlong (Vigna sesquipedalis) 746
  Common Mosaic 745
  Common Mosaic Necrosis 745
  Common Mosaic Potyvirus 607
  Faba (Vicia) 743
  Golden Mosaic 704, 745
  Halo Blight 118

Kidney, Lima (Phaseolus vulgaris, P. limensis) 743
Leaf Roll 795, 1000
Leaf Roll Luteovirus 607
Mosaic 745
Mosaic = Bean Common Mosaic Potyvirus 607
Mung (Phaseolus aureus) 746
Phyllody 130, 745
Pod Mottle 745, 1080
Pod Mottle Comovirus 607
Red Node 745
Rust 569
Scarlet Runner (Phaseolus coccineus) 746
Southern Mosaic Sobemovirus 608
Tepary (Phaseolas acutifolius) 746
Urd (Vigna) 747
Yellow Dot 745
Yellow Mosaic 745, 865, 945, 1105, 1107, 1124, 1142
Yellow Mosaic Potyvirus 608
Yellow Mosaic Virus 1121
Yellow Stipple 745
Yellow Stipple = Cowpea Chlorotic Mottle Bromovirus 608
Bearberry (Arctostaphylos uva-ursi) 747
Beauty-Bush (Kolkwitzia) 747
Beech (Fagus) 747
Beet
2 Alphacryptovirus 608, 749
Black Scorch 608, 749
Curly Top 713, 734, 745, 746, 749, 768, 772, 781, 783, 787, 808, 812, 815, 822, 830, 833, 842, 864, 871, 876, 877, 890, 900, 911, 923, 928, 942, 950, 955, 960, 965, 975, 977, 978, 989, 995, 996, 1012, 1015, 1032, 1033, 1036, 1043, 1045, 1050, 1061, 1062, 1065, 1080, 1082, 1087, 1091, 1095, 1102–1104, 1112, 1120, 1128, 1134, 1138, 1144
Curly Top Hybrigeminivirus 608
Distortion Mosaic 749
Distortion Mosaic Virus 609
Downy Mildew 278, 279
Latent 749
Latent Virus 610
Mosaic 749, 1104
Mosaic Potyvirus 610
Necrotic Yellow Vein 749
Necrotic Yellow Vein Tobamovirus 610
Pseudo-Yellows 749, 754, 1082, 1087
Pseudo-Yellows Closterovirus 610
Ring Mottle 610, 749, 1082
Rust 570
Savoy 610, 749
Scab 575
Soilborne 749
Soilborne Mosaic 749
Western Yellows 749
Western Yellows Luteovirus 610
Western Yellows Virus 1066
Yellow Net 749
Yellow Net Luteovirus 611
Yellow Vein 749
Yellows 749
Yellows Closterovirus 611
Beet (Beta vulgaris) 748
Beggarweed, Florida (Desmodium tortuosum) 750
Begomoviruses 951
Begonia 750
Bacteriosis 122, 123
Mildew 446
Bells-Of-Ireland (Molucella) 751
Belonolaimus 389
gracilis 389, 749, 767, 787, 846, 887, 934, 945, 985, 999, 1001, 1003, 1021, 1034, 1053, 1079, 1093, 1101
longicaudatus 390, 767, 787, 836, 887, 949, 1003, 1034, 1079
Benalaxyl 16

Beniowskia 154
sphaeroidea 154, 761, 928
Benzalkonium Chloride 26
Bermuda Grass Leaf Blotch 330, 332
Betacryptovirus 71
Bidens
(Bur-Marigold) 751
Mottle 611, 751, 945, 1013
Mottle Potyvirus 611
Bidens Mottle 708, 734, 743, 772, 830, 867, 1015, 1057, 1092, 1095, 1098, 1124, 1144
Bifusella 375
abietis 376, 861
crepidiformis 1084
faullii 376, 861
linearis 376, 1020
saccata 376, 1020
striiformis 1020
Bigeminivirus 71
Bignonia
(Crossvine) 751
Bigseed Alfalfa Dodder 274
Bindweed, Field (Convolvulus) 751
Biopolairs
sacchari 855
Bipolaris
cactivora 489
cyanodontis 885
cynodontis 330
hawaiiensis 886
heveae 1062
iridis 187
sacchari 1104
setariae 330, 780, 800, 871, 991–993, 1053, 1074
sorokinearia 744
sorokiniana 330, 886, 1136
Birch
(Betula) 751
Leaf Rust 554
Red Leaf Blister 295
Bird's Eye Rot 596
Bird's Nest Fungus 284
Bird-Of-Paradise (Strelitzia) 752
Bischofia 752
Biscogniauxia marginata 254
Bishops-Cap (Mitella) 752
Bispora sp. 756
Bitertanol 16
Bitter Pit 416, 720, 896, 984, 1005
Bitter Rot 468, 485, 486, 494
Bittercress (Cardamine) 753
Bittersweet (Celastrus) 753
Bixa (Annato-Tree) 753
Black
Bearberry (Arctous) 753
Cane Rot 466
Crown Rot 464
End 416, 720, 1005, 1131
Fruit Rot 462
Goo 196
Heart 416, 720, 749, 782, 787, 1034
Knot 134, 136
Leaf 326, 1005
Leaf Speck 364
Leaf Spot 303, 315, 328, 329, 339, 348
Line 1131
Loose Smut 589
Mildew 140–143, 340
Mold 151, 373, 461
Nose 991
Patch 136
Pit 1008
Pod Spot 198
Pox 287
Pustule 257
Raspberry Necrosis 1046
Raspberry Witches' Broom Phytoplasma 1046
Root 417, 1093
Rot 122, 123, 199, 200, 456, 462, 466, 472, 488, 508, 509, 525, 530, 533
Rot Canker 258, 259
Scale Rot 469
Scorch 298

Scurf 308, 501, 522
Seed Rot 363
Sigatoka 187
Spot 112, 140, 308, 319, 325, 328, 339, 353, 364, 572, 573, 576
Stem Rot 474
Stem Spot 342
Wart 293
Black Dot Disease 86
Black-Seed Disease 341
Blackberry
(Rubus) 753
Dwarf 611
Dwarfing 611, 754
Leaf Spot 361
Mosaic 611, 754
Variegation 611, 754
Blackberry-
Lily (Belamcanda) 754
Blackening
after Cooking 1034
before Cooking 1034
Blackeye
Cowpea Mosaic 611
Blackfire 113, 115, 119, 120
Blackleg 137, 138
Bladder-Senna (Colutea) 755
Blanket Flower (Gaillardia grandiflora) 755
Blast 353, 487, 488, 985
Blasting 417
Bleeding
Canker 259, 264
Bleeding-Heart
(Dicentra spectabilis) 755
Vine (Clerodendrin) 755
Blephilia 755
Blight 113–115, 121, 124, 152–154, 163, 170, 171, 175, 176, 179, 180, 185, 187, 196, 197, 206–208, 211, 241, 248, 250, 277, 285, 303, 312, 316, 318, 349, 463, 484, 573, 804, 937, 1099
Foliage 150
Blight and Wilt 687
Blind Seed Rot 486
Blindness 417, 918
Blister Canker 233, 254
Blister Spot 118
Bloodroot
Leaf Spot 350
Bloodroot (Sanguinaria) 755
Blossom Blight 124, 156, 166, 167, 186
Blossom Drop 744
Blossom-End Rot 417, 1012, 1087, 1111, 1133
Blotch 198, 213, 322, 323
Blotchy Ripening 1111
Blue
Contact Mold 503
Curls (Trichostema) 757
Lace-Flower (Trachymene) 757
Mold 279
Mold Rot 503
Stain 1003
Blue Cohosh (Caulophyllum) 757
Blue-Eyed Grass (Sisyrinchium) 757
Blueberry
Brown Rot 497
Bud-Proliferating Gall 292
Cane Canker 257, 258
Canker 121
Leaf Mottle 757
Leaf Mottle Nepovirus 612
Necrotic Ring Spot 612, 757
Necrotic Shock 757
Necrotic Shock Ilarvirus 612
Red Ring Spot 757
Red Ring Spot Caulimovirus 612
Ring Spot 612
Scorch 757, 978
Scorch Carlavirus 612
Shoestring 757
Shoestring Sobemovirus 612
Stunt 757
Stunt Phytoplasma 613
Twig Blight 173
Witches' Broom 566

Blueberry (Vaccinium) 756
Bluegrass
  Blister Smut 584
  Leaf Rust 560, 564
  Leaf Spot 331, 332
Bluestem, Big (Andropogon) 758
Bluestem, Little (Schizachyrium) 758
Blumeria graminis 441, 444, 762
Blumeriella
  (Coccomyces) 316
  jaapii 316, 317
  kerriae 317
Boehmeria 758
Boil Smut 589
Boisduvalia 758
Bole Canker 236
Boletaceae 61
Boll Rot 468
Boltonia 758
Borage (Borago) 758
Bordeaux Injury 417
Bordeaux Mixture 16
Boron Deficiency 418, 771, 904, 1050, 1053
Boron Toxicity 419
Bostryosphaeria ribis var. chromogena 822
Botryodiplodia 155, 226
  gallae 226, 243, 980
  theobormoae 461
  theobromae 226, 721, 842, 1025, 1052
  theobromea 803
Botryosphaeria 155, 226, 461
  berengeriana 902, 1007
  calycanthi 774
  corticis 257, 756
  dothidea 226, 461, 711, 719, 754, 756, 884, 1000, 1001, 1005, 1068, 1099
  marconii 899
  obtusa 199, 226, 257, 462, 508, 721, 754, 883, 1001
  quercuum 258
  rhodina 258, 462, 508, 883, 1024
  ribis 226, 462, 719, 725, 741, 775, 781, 793, 804, 823, 836, 843, 844, 849, 858, 864, 879, 881, 900, 1006, 1014, 1040–1042, 1045, 1048, 1068, 1096, 1118, 1137, 1142
  ribis var. chromogena 155, 736, 770, 909, 1000, 1031, 1047, 1052, 1081, 1099
  stevensii 227, 508, 925
  vaccinii 487
  vanillae 1122
Botryosphaeria sp. 825, 883, 939
Botryosporium 372
  pulchrum 372, 871, 1111
Botryotinia 156, 462
  convoluta 462, 918
  fuckeliana 156
  narcissicola 524
  polyblastis 209, 974
  ricini 156, 784
  sphaerosperma 937
Botrytis 156, 227, 308, 462
  aclada 462
  allii 985, 1069
  Blight 156, 160, 161
  byssoidea 463
  cinerea 156, 227, 463, 707, 709, 711–713, 716, 724, 726, 729, 732–734, 737, 739, 741, 743, 750, 754–756, 767, 769, 771, 773, 775–778, 780, 782, 785, 787, 789, 792, 799–801, 804, 805, 809, 810, 812, 818, 821–824, 826, 829, 831–833, 836, 837, 840, 842, 846–848, 850–856, 859, 863, 866, 868, 870–872, 874, 877, 878, 881, 884, 892, 895, 897–899, 903, 907, 912, 913, 918, 934, 936, 937, 939, 941, 944, 946, 956, 958, 963, 966, 974, 975, 982, 985, 987–989, 994, 996, 999, 1001, 1003, 1004, 1006, 1007, 1009, 1012, 1014, 1016, 1019,

1024, 1026, 1027, 1029, 1030, 1032, 1035, 1038, 1040, 1041, 1044, 1046, 1050, 1052, 1054, 1058, 1059, 1064, 1068, 1071, 1073, 1075, 1078, 1083, 1087, 1090–1092, 1097, 1100, 1102, 1109, 1110, 1112, 1114, 1116, 1123, 1125, 1126, 1128, 1129, 1144, color plates 14, 15
Crown Rot 462
douglasii 159, 930, 1068
elliptica 159, 736, 849, 875, 937, 1090, 1116
fabae 308, 1125
galanthina 160, 1075
gladiolorum 160, 463, 875
hyacinthi 160, 913
liliorum 937
narcissicola 160
Neck Rot 463
paeoniae 160, 938, 1009
polyblastis 161
porri 463, 985
ricini 771
squamosa 463, 985
streptothrix 161, 757, 810, 878, 1071
tulipae 161, 463, 1116, 1126
Botrytis sp. 828, 849, 880, 914, 935, 950, 983
Botrytis spp. 721
Botrytris
cinerea 997
Bottle-Brush (Callistemon) 758
Bottom Rot 520, 522
Bougainvillea (Buginvillaea) 759
Bouvardia 759
Boxelder (Acer negundo) 759
Boxwood
(Buxus) 760
Leaf Blight 217
Spiral Nematode 408
Tip Blight 197
Boxwood Nectria Canker 267
Boydia insculpta 904
Boysenberry 759
Brachiaria
platyphylla 885
Brachiaria (Broadleaf signalgrass) 761
Brachycome (Swan River Daisy) 761
Brachypodium (Slender False-Brome) 761
Brachysporium 463
tomato 463, 1112
Bramble
Anthracnose 599
Branch
and Truck Canker 225, 226
Canker 243
Dieback 200, 241, 256
Gall Canker 249
Mortality 236
Necrosis 234
Rot 689
Wilt 692
Branch Canker 237, 239, 243
Branched Broomrapeh 223
Brasiliomyces trina 441
Brassica
alboglabra 768
carinata 768
napus 768
perviridis 768
rapa 778
robertiana 768
Bremia 275
lactucae 276, 788, 846, 894, 928, 934, 1037
Bremiella
megasperma 1127
sphaerosperma 915
Brickellia (Brickle-Bush) 761
Briosia 163
amphelophaga 883
azalea 1048
azaleae 163, 737
Bristlegrass (Setaria) 761
Broad
Bean Severe Chlorosis 1125

Bean Severe Chlorosis Closterovirus 613
Bean Wilt 750, 788, 1108, 1121, 1123, 1125
Bean Wilt Fabavirus 613
Broccoli 761
Brodiaea 762
Brome
Grass Mosaic 613
Mosaic 816
Mosaic Bromovirus 613
Bromegrass
Mosaic 745, 828, 889, 1015, 1087, 1098
Mosaic Virus 742, 821
Smooth (Bromus) 762
Bromelia 762
Bromovirus 71
Bronopol 26
Bronze Leaf 744
Bronzing 749, 804, 1087, 1118
Brooks Fruit Spot 287
Broom
(Cytisus) 762
Spanish (Spartium) 762
Brooming Disease 1077, 1131
Broussonetia (Paper-Mulberry) 762
Browallia (Streptosolen jamesonii) 763
Brown
Bark Spot 419
Blight 331, 332, 934
Blotch 1005
Core 720
Core Rot 511
Crumbly Rot 478, 529
Cubical Rot 470, 473, 515, 516
Felt Blight 181, 188
Heart 419, 768, 846, 1120
Heart Rot 514
Leaf Blotch 222, 359
Leaf Spot 321, 1098
Mottled Heart Rot 505
Patch 502, 522
Pocket Rot 478, 489, 492, 528
Root 1093
Root Rot 197
Rot 115, 121, 186, 494, 495, 504, 510, 512, 517, 518
Scale 469
Spot 112, 114, 304, 352, 360
Spot, Foliar 119
Stain 896
Stem 787
Stem Rot 464
Stringy Rot 476
Stripe 357, 358
Tip 875
Trunk Rot 478
Brown Bark Spot 792, 1005, 1027
Brunchorstia boycei 838
Brunfelsia 763
Brussels Sprouts 763
Bryonopsis 763
Bubakia
crotonis 820
erythroxylonis 536
Bubakia (Phakopsora) 536
Buckeye 763
Leaf Blotch 220
Rot 512
Buckleya 763
Buckthorn (Rhamnus) 763
Buckwheat-Tree (Cliftonia) 764
Bud
and Flower Blight 156
and Leaf Nematode 389
and Twig Blight 163
Blast 160, 937, 1010
Blight Leaf 179
Drop 419, 868, 1101
Drop, Dieback 775
Failure 711
Gall 290
Proliferation 133
Rot 502, 503
Scorch 298
Buddleia (Butterfly-Bush) 764

Buffaloberry
(Shepherdia) 764
Buffalograss
(Buchloe) 764
Bugleweed (Ajuga) 765
Bulb Decay 104, 111
Bulb Rot 463, 481, 483
Bumelia 765
Bunch Disease 1008
Bunch Mold 461
Bunchflower (Melanthium) 765
Bundleflower (Desmanthus) 765
Bunt 586, 587
Bupirimate 17
Burgundy Mix 17
Burkholderia
andropogonis 112, 759
caryophylli 112
cepacia 17, 113
gladioli 113, 987
Burn 887
Burnet (Sanguisorba) 765
Burrillia 583
decipiens 583, 979
pustulata 728
Burrowing Nematode 407
Bursaphelenchus 390
lignicolus 390, 1021
xylophilus 390, 1021
Butlerelfia eustacei 470
Butt Rot 485
Butterfly Pea
(Centrosema) 766
(Clitoria) 766
Butterfly Weed (Asclepias) 766
Butterfly-Flower (Schizanthus) 765
Butternut Dieback 250
Buttonbush (Cephalanthus) 766
Bymovirus 71
C. pteleae 909
Cabbage
(Brassica oleracea) (Including Broccoli, Brussels Sprouts, Cauliflower, Kale, Kohl-rabi) 767
Black Ring Spot 613
Cyst Nematode 396
Leaf Curl 768
Leaf Spot 304
Ring Necrosis 768
Ring Necrosis = Turnip Mosaic Potyvirus 614
Yellows 688
Cacopaurus 390
pestis 390
Cactodera estonica 1079
Cactus
(Cereus) 768
(Leuchtenbergia principis and Schlumbergera gaertneri Makoyana) 769
Anthracnose 95
Cyst Nematode 396
Fishhook, Pincushion (Mammillaria) 769
Giant, Saguaro (Carnegiea) 769
Prickly Pear (Opuntia) 770
Star, Sea-Urchin, Barrel (Echinocactus) 770
Virus X 978
X. Potexvirus 614
Caeoma 536
dubium 898
faulliana 536, 862
torreyae 536
Caesalpinia 770
Caladium 770
Calathea 771
Calceolaria (Slipperwort) 771
Calcium Chloride Injury 420
Calcium Deficiency 420
Calendula
(Pot Marigold) 771

Leaf Spot 311
White Smut 584
Calibrachoa
(Calibrachoa sp.) 772
Mottle 772, 1015
Mottle Carmovirus 614
Caliciopsis 227
nigra 925
pinea 227, 1019
California
Aster Yellows 130, 771, 773, 776, 779, 787, 788, 805, 812, 814, 815, 829, 846, 847, 863, 867, 869, 873, 877–879, 892, 897, 900, 933, 950, 955, 957, 963, 975, 984, 996, 997, 1016, 1037, 1042, 1044, 1056–1058, 1060, 1061, 1065, 1067, 1089, 1095, 1097, 1103, 1129, 1144
Chinquapin Leaf Blister 295
Dagger Nematode 412
Mistletoe 369
Pepper-Tree (Schinus) 772
Pitcher-Plant (Darlingtonia) 773
Poppy (Eschscholtzia) 773
Sessile Nematode 404
California-Bluebell (Phacelia) 772
California-Laurel (Umbellularia) 772
California-Rose (Convolvulus japonicus) 773
Calla
Chlorotic Spot 774
Common, Golden, Pink (Zantedeschia) 773
Leaf Spot 350
Wild (Calla palustris) 774
Calliandra (False-Mesquite) 774
Callicarpa
(Beauty-Berry; French-Mulberry) 774
Callus Knot 720
Calonectria 163, 308, 463
colhounii 163, 308, 704, 935, 992
crotalariae 308, 463, 984, 992, 1004, 1079
graminicola 888
theae 308, 992
Calonectria sp. 463, 995
Caloscypha fulgens 1084
Calycanthus (Sweetshrub, Carolina Allspice) 774
Calyx-End Rot 457, 461, 525
Camass (Camassia) 775
Camellia 775
Dieback 245
Flower Blight 209, 211
Leaf Gall 289
Leaf Spot 345, 349, 363
Scab 598
Yellow Mottle Leaf 776
Yellow Mottle Varicosavirus 614
Camomile (Anthemis) 776
Campanula (Bellflower, Canterbury Bells) 776
Campestris 725
Camphor-Tree
(Cinnamomum) 777
Scab 596
Canavirgella 376
banfieldii 376, 1020
Cancroid Spot 804
Candida krusei 804
Candidatus
asteris 778
brasiliense 1013
Phytoplasma asteris 1035
Candlestick Shrub (Cassia) 777
Candytuft (Iberis) 777
Cane Blight 179, 185, 199, 200
Cane Gall 98
Cane Knot Canker 265
Cane Rust 552
Cane Spot 225, 262
Canker 91, 115, 155, 183, 197, 199, 200, 214, 225–227, 229, 230, 232, 233, 235–246, 248–250, 252, 255–

257, 259–266, 293, 343, 473, 486, 574, 692, 898
Canker Stain of London Plane 228
Cankers 292
Canna 777
Mosaic 614
Yellow Mottle 778
Yellow Mottle Badnavirus 614
Canola
(Brassica napus) 778
Cantaloupe 778
Cape-Cowslip (Lachenalia) 778
Cape-Honeysuckle (Tecomaria) 778
Cape-Marigold (Dimorphotheca) 778
Caper
(Capparis) 779
Capeweed, Cape Dandelion (Arctotheca calendula) 779
Capillovirus 71
Capnodiaceae 54
Capnodium 594
axiliatum 785
citri 594, 805, 987
citricola 805
elongatum 595, 751, 904, 906, 984, 1117
footii 717
grandisporum 781, 1135
pini 1023
Capnodium sp. 764, 809, 859, 996, 1016, 1138
Capnodium spp. 595, 818, 868, 952, 1141
Capsule Spot 333, 334
Captan 17
Carapace Spot 736
Caraway (Carum) 779
Carbendazim 17
Carbofuran 28
Carbon Disulfide 17
Carboxin 17
Cardoon (Cynara cardunculus) 779
Carissa 779
(Natal-Plum) 779
Carlavirus 71, 897
Carmovirus 71
Carnation
(Dianthus caryophyllus) 780
Bud Rot 483
Collar Blight 152
Downy Mildew 277
Etch-Ring 781
Etched Ring Caulimovirus 615
Fusarium Wilt 689
Italian Ring Spot 781
Italian Ringspot Tombusvirus 615
Latent 781
latent 833
Latent Carlavirus 615
Mosaic 615, 781, 1103
Mottle 781
Mottle Carmovirus 615
Necrotic Fleck 781
Necrotic Fleck Closterovirus 615
Pimple 126, 129
Pin Nematode 404
Powdery Mildew 446
Ring Spot 781
Ring Spot Dianthovirus 615
Rust 570
Streak 616, 781
Vein Mottle 781
Vein Mottle Potyvirus 616
Yellows 616, 781
Carob, St. Johns Bread (Ceratonia) 781
Carolina Geranium (Geranium carolinianum) 781
Carolina Jessamine (Gelsemium) 781
Carolina Moonseed (Cocculus) 781
Carolina Spiral Nematode 409
Carpetweed (Mollugo) 782
Carrot
(Daucus carota var. sativa) 782
Cyst Nematode 396
Leaf Blight 151
Motley Dwarf 783
Motley Dwarf = Carrot Mottle Umbrarvirus 616

Purple Leaf 783
Red Leaf 783
Red Leaf Luteovirus 616
Thin Leaf 783
Thin Leaf Potyvirus 616
Wild (Daucus carota) 783
Cascara (Ramnus ramorum) 783
Cashew (Anacardium) 783
Cassabana, Curuba (Sicana) 783
Cassava
Common Mosaic 952
Common Mosaic Potexvirus 616
Cassia
(Senna, Sicklepod, Partridgepea) 783
Cassiope 784
Cassytha filiformis 803, 987
Cast 380
Castor-Bean (Ricinus communis) 784
Casuarina (Australian-Pine) 784
Cat-Tail (Typha) 786
Catalina Cherry (Prunus lyoni) 784
Catalpa 785
Leaf Spot 304, 349
Catenularia 463
Catenularia fuliginea 464, 992
Catface 420, 1001, 1111
Catha (Arabian-Tea) 785
Catkin Hypertrophy 297
Catnip (Nepeta) 785
Cats-Claw (Doxantha) 786
Cattleya Blossom Brown Necrotic Streak 987
Cattleya Dry Sepal 987
Cauliflower
Mosaic 768, 796, 973, 1091
Mosaic Caulimovirus 617
Caulimovirus 71
Ceanothus 786
Cedar
(Cedrus spp.) (Atlas Cedar, Deodar, Cedar of Lebanon) 786
Blight 197
Cedar-Apple Rust 549
Celandine (Chelidonium) 786
Celery
Brown Spot 309
Calico 617, 787, 830
Celeriac (Apium graveolens) 787
Late Blight 212
Mosaic 783, 787
Mosaic Potyvirus 617
Pin Nematode 404
Wilt 687
Yellow Dwarf Poleroviridae 617
Yellow Spot 787
Yellow Spot Luteovirus 617
Celtuce (Lactuca serriota var. sativa) 788
Cenangium 163
ferruginosum 164, 860, 1019
singulare 228, 1031
Cenangium Dieback 164
Cenchrus (Buffelgrass) 788
Centaurea (Bachelors-Button, Basketflower; Cornflower; Dusty-miller, Yellow Starthistle) 788
Centipede
Grass (Eremochloa) 789
Centrospora acerina 464, 783, 787, 995, 997, 1127
Century
Plant (Agave) 789
Cephaleuros 308
Cephaleuros virescens 308, 704, 717, 718, 727, 736, 752–754, 775, 777, 802, 803, 809, 868, 889, 891, 922, 929, 931, 932, 944, 949, 952, 1007, 1014, 1038, 1048, 1105, 1106, 1126
Cephalosporium 309, 464
acremonium 813, 859
apii 309, 787
carpogenum 464, 721, 1006
cinnamomeum 310, 977, 1105
dieffenbachiae 310, 833
diospyri 682, 1014
gregatum 464, 745, 1079
Cephalosporium sp. 682, 756, 844, 860, 914, 960, 980, 1118

Cephalosporium Wilt 686
Cephalotaxus (Japanese Plum-Yew) 789
Cephalothecium roseum 1001, 1041
Ceratobasidium anceps 807, 835, 856, 914, 943, 1044, 1089
Ceratocystis 298, 464
(Ceratostomella) 228
(Ceratostomella) ulmi 683
coerulescens 954
fagacearum 682, 797, 982
fimbriata 465, 711, 723, 922, 969, 1000, 1026, 1031, 1102, 1105
fimbriata f. sp. platani 228, 1025
paradoxa 298, 991, 1023
tremullo-aurea 1031
ulmi 845
wageneri 466, 1021
Ceratocystis sp. 229, 1031
Ceratophorum ulmicola 844
Ceratostomataceae 55
Ceratostomella radiciola 992
Cercoseptoria
blephiliae 755, 971
caryigena 909
minuta 776
Cercospora 164, 218, 310
abeliae 310, 703
abelmoschi 310, 983
acalyphae 705
acetosellae 1057
adusta 1038
aeruginosa 763
aesculina 910
afflata 909
ageratoides 851
alabamensis 921, 968
albo-maculans 310
alismatis 728
alni 709
althaeina 310, 905, 1032
amalayensis 901
amaryllidis 713, 951, 1044, 1081
amelopsidis 920
ampelopsidis 1128
anethi 834
angulata 310, 823, 881, 966
anomala 705
antipus 907
antirrhini 1074
apii 164, 751, 787
apii f. sp. clerodendri 807
apii var. angelicae 717
apiifoliae 894
apocyni 835
aquilegiae 310, 810
arachidicola 310
arboreae 802, 1013
arborescentis 913
armoraciae 311, 911
asclepiadorae 766
asiminae 998
asparagi 732
asterata 734
atrogrisea 1043
atromaculans 725, 900
aurantia 803
avicennae 703
Bacilligera 763
barbarea 1138
bellynckii 1127
beticola 311, 748, 1058, 1082, 1104, 1121
biformis 997
bixae 753
boerhaaviae 1081
bougainvilleae 311, 759
brassicicola 973, 1119
brassicola 767, 796
brunkii 311, 871
brunnea 1037
caldosporioides 984
calendulae 311, 771
callae 728, 774
callicarpae 774
calthae 956
camptosori 857
cana 848
canescens 713, 744, 784, 837, 1078

cannabina 311, 899
cannabis 311, 899
capitati crotonicola 820
capreolata 751
capsici 311, 1011
carii 842
carotae 165, 782
catalpae 785
catenospora 843
caulophylli 757, 1057
ceanothi 786
cebrina 816
celosiae 808
cercidis 1047
chionanthi 866
chrysanthemi 800, 1069
chrysobalani 809
cichorii 846
cinchonae 801
circumscissa 311, 711, 723, 792, 794, 799, 1001, 1026
citri-grisea 803
citrullina 312, 1086, 1133
cladosporioides 794
clavata 766
clavicarpa 1090
cleomis 806
clitoriae 766
cocculicola 781
coleosanthi 761
concentrica 1142
concors 218, 312, 1033
condensata 907
consobrina 1001
consociata 1057
conspicua 806
coreopsidis 812
cornicola 312, 836
corylina 896
crassoides 866
crotonifolia 820
crotonis 820
crotonophila 820
cruciferarum 1043
cruenta 746, 766
cucurbitae 821, 882, 1086
cydoniae 1042
cynoglossi 825, 929
cypripedii 987, 988
daemonicola 831
daleae 1073
decumariae 828
delphinii 829
dendrobii 987
depazeoides 843
desmanthi 765
destructiva 850
deutziae 831
diffusa 890
dioscoreae 1141
diospyri 1014
dispersa 1135
dubia 1061
dulcamerae 923
duplicata 1115
echii 1128
echinocystis 965
effusa 941
elaeagni 842
elongata 1106
epigaeae 847
epipactidis 987
eriobotryae 1017
erysimi 1129
erythrogena 958, 1048
euonymi 850
euphorbiae 1085
euphorbiicola 1075
eustomae 852
exotica 1132
ferruginae 728
ferruginea 1059
fici 858
fingens 958
flagellaris 1056
floricola 1142
fragariae 1093
fraserae 811

fraxinites 731
fukushiana 915
fuliginosa 1014
fulvella 1124
fusca 312, 902, 1007
fuscomaculans 886
fuscovirens 997
galii 867
garryae 869, 1071
gaultheriae 747, 869, 1138
gaurae 869
gayophyti 891
gei 873
gentianae 870
gentianicola 870
geranii 872
gigantea 803
glandulosa 708
gnaphaliacea 877
gomphrenae 876
gonolobi 1062
granuliformis 1127
graphioides 792
grindeliae 889
grisea 963
guttulata 840
gymnocladi 927
halesiae 893
handelii 1049
helenii 897
helianthi 729, 1097
heliotropii 898
hemerocallis 828
henningsii 952
heteromeles 1017
heterospora 1085
heucherae 901
hibisci 901, 1055
hieracii 894
houstoniae 912
hydrangeae 913
hyperici 1060
ilicis 904, 917
insulana 1090
juglandis 1130
jujubae 924
jussiaeae 1134
kalmiae 971
kellermanii 905, 1055
kikuchii 1078
kolkwitziae 747
laburni 878
lanuginosa 765
lathyrina 312, 1100
Leaf Spot 311
leonotidis 940
leptandrae 822
leptosperma 725
leucosticta 795
leucothoës 935
ligustri 1038
lilacis 936
lippiae 940
liquidambaris 1099
lobeliae 941
longispora 945
longissima 934
ludwigiae 944
lupini 945
lupinicola 945
lutescens 799
lycii 946, 957
lycopi 1132
lysimachiae 943
lythracearum 312, 818, 947
lythri 947
maclurae 988
macrochaeta 980
macroguttata 801
magnoliae 312, 948
malachrae 950
malayensis 983, 1055
mali 719, 798
malkoffi 717
malloti 950
maritima 820
marrubii 903
melanochaeta 753

meliae 795
melongenae 312, 841
menispermi 968
menthicola 964
microsora 165, 939
mikaniae 963
mimuli 964
minima 1005
mirabilis 864
mitellae 752
montana 847
moricola 972
morindicola 968
morongiae 1065
nandinae 312, 974
nasturtii 830, 1131
negundinis 759, 953
nelumbonis 944
nepetae 785
nepheloides 852
neriella 983
nigricans 784
noveboracensis 919
nymphaeacea 1132
nyssae 1118
obscura 729, 779
oculata 919
odontoglossi 987
oenotherae 982
oenotherae-sinutae 982
olivacea 728, 941, 1030, 1059
omphakodes 1016, 1030
opuli 1125
osmorhizae 1103
oxalidiphila 989
oxybaphi 710, 1121
oxydendri 989
pachypus 1097
paeoniae 1009
pancratii 819, 1081
papaveri 1032
parvimaculans 880
pastinacae 997
pastinacina 997
penstemonis 1009
peristeriae 987
perniciosa 766
perseae 736
personata 312
petroselini 996
petuniae 1015
photiniae-serrulata 1017
phyllitidis 857
physalicola 890
physalidis 890
physaloides 722
piaropi 312, 1132
piri 798
pisi-sativae 999
pittospori 312, 1024
platanicola 1025
plumeriae 1028
poagena 886
podophylli 958
populicola 1031
populina 1031
prenanthis 1037
prosopidis 962
psedericola 1128
psidii 891
puderi 312, 1052
pulcherrimae 1029, 1075
pulsatillae 716
purpurea 218, 736, 1047
pustulata 920
pyri 1005
ranunculi 1044
ratibida 1047
regalis 997
repens 811
resedae 312, 962
rhamni 763
rhapontici 1050
rhizophorae 952
rhododendri 313, 738
rhoina 1073, 1096
ribicola 823
ribis 823

richardiaecola 313, 774
ricinella 784
rosicola 313
rubigo 806, 1082
rudbeckiae 879, 1056
rudbeckii 840
sabbatiae 1055
saccharini 953
salicina 1137
salviicola 1058
sanguinariae 755
saururi 1064
scutellariae 1071
sechii 791
seminalis 886
senecionicola 1067
senecionis 1067
sequoiae 165, 1067
sequoiae var. juniperi 924
sesami 1068
sidicola 1070
silphii 1071
smilacina 1072
smilacis 313, 1072
sojina 313, 1078
sordida 165
speculariae 1080
sphaeriaeformis 844
spiraea 979
Spot 218, 219, 313
squalidula 806
stachydis 1088
stillingiae 797, 1091
stizolobii 1122
streptopi 1095
stromatis 894
struthanthi 965
subsessilis 795
symphoricarpi 812, 1075, 1139
symplocarpi 313, 1071
tabacina 1037, 1056
tageticola 956
ternateae 921
tetragoniae 977
teucrii 873
thaliae 1107
thaspii 717
theae 775
thermopsidis 1107
thujina 726, 825
tinea 1125
tortipes 1125
tragopogonis 1061
triostei 910
tropaeoli 975
truncata 715
truncatella 998
tuberculans 1099
unamunoi 1011
varia 907, 1125
velutina 741
venturioides 766
verbasicola 972
verbenicola 1124
vexans 1093
violae 995, 1127
viticis 1129
viticola 802
vitis 715, 1013
websteri 1118
weigelae 1135
weigeliae 834
xanthoxyli 900, 1037
zeae-maydis 813
zebrina 313, 744, 807, 891, 933, 1003, 1079, 1114
zinniae 1144
ziziae 1144
Cercospora menispermi 781
Cercospora sp. 313, 704, 706, 708, 727, 748, 750, 775, 815, 818, 826, 847, 854, 878, 879, 908, 926, 937, 949, 956, 960, 966, 990, 993, 1017, 1050, 1090, 1101, 1116
Cercospora spp. 802, 1107, 1110
Cercosporella 315
aceris 954
acroptili 705, 1057

alni 709
brassicae 315, 767, 796, 973, 1119
cana 734
celtidis 892
chionea 1047
colubrina 848
filiformis 716, 958
idahoensis 1077
lilii 937
mirabilis 894
mori 972
nivosa 1009
pastinacae 997
pastinaceae 354
pirina 817
primulae 1038
prolificans 843
pycnanthemi 971
rubi 754, 832, 1046
saxifragae 1064
terminalis 1123
Cercosporidium 165
bougainvilleae 313
fasciculatum 1085
graminis 357
magnoliae 313
personata 315
personatum 1003
punctum 165, 853
Cercosporidum 315
Cereal Anthracnose 87
Cerotelium 537
dicentrae 537, 840
fici 537, 859, 972, 988
Cerotelium fici 859
Cerrena unicolor 473
Cestrum 789
Ceuthocarpon ferrugineum 947
Ceuthocarpum conflictum 941
Ceuthospora lunata 466, 817
Chaerophyllum 789
Chaetoderma luna 504
Chaetodiplodia sp. 987
Chaetomella sp. 721
Chaetomiaceae 55
Chaetomium bostrychodes 1111
Chalara
thielavioides 373
thielaviopsis 466
Chalara (Chalaropsis) 373, 466
Chalaropsis
thielavioides 373, 1052
thielaviopsis 466, 1029
Chalk rot 774
Chalking 1116
Chamaecyparis (Atlantic White-Cedar, Port Orford White-Cedar, Alaska Yellow-Cedar, Hinoki Cypress, Sawara Cypress-Retinospora) 790
Chamaedaphne (Cassandra, Leatherleaf) 790
Chamber's Dagger Nematode 412
Char Spot 359
Charcoal Rot 185, 493, 521
Charcoal Spot 325
Chard Blue Mold 277
Chayote (Sechium) 791
Checker Mallow (Sidalcea) 791
Checking 1034
Cheilaria agrostis 353, 359
Chenopodium 791
Cherimoya, Custard-Apple (Annona) 791
Cherry
(Flowering) Rough Bark 620, 793
(Prunus spp.) 791
(Sour) Pink Fruit 619
Albino 618, 793
Bark Splitting 618, 793
Black Canker 618, 793
Buckskin 618, 793
Bud Abortion 618, 793
Calico 995
Chlorosis 618, 793
Flowering, Oriental (Prunus serrulata) 793
Freckle Fruit Disease 618, 793
Green Ring Mottle 618, 793

Gummosis 618, 793
Japanese Flowering (Prunus subhirtella) 793
Leaf Blight 182
Leaf Spot 304, 316, 318
Little Cherry 619, 793
Midleaf Necrosis 619, 793
Mora 619, 793
Mottle Leaf 793
Mottle Leaf Trichovirus 619
Necrotic Rusty Mottle 619, 793
Pink Fruit 793
Pinto Leaf 619, 793
Rasp Leaf 793
Rasp Leaf Nepovirus 620
Ring Spot 793
Ring Spot = Prunus Necrotic Ringspot Ilarvirus 620
Rough Fruit 793
Rugose Mosaic 793
Rugose Mosaic = Strain of Prunus Necrotic Ringspot Ilarvirus 620
Rusty Mottle 620, 793
Twisted Leaf 621, 793
Vein Clearing 621, 793, 1027
Witches' Broom 297
Yellows 793, 1002
Yellows = Prune Dwarf Ilarvirus 621
Cherry-Laurel
(Prunus laurocerasus) 794
Chestnut
(Castanea) 794
Blight 176
Chick-Pea
Garbanzo (Cicer) 795
Chickory 794
Chickpea
filiform 795
Filiform Potyvirus 621
Chickweed (Stellaria and Cerastium) 795
Chinaberry
(Melia) 795
Chinese
Cabbage (Brassica pekinensis, B. chinensis) 796
Evergreen (Aglaonema) 796
Holly Spot Anthracnose 598
Chinese Lantern (Physalis alkekengi) 796
Chinese Tallowtree (Sapium) 797
Chinese Waxgourd (Beincasa) 797
Chinquapin (Castanopsis) 797
Chiogenes (Creeping Snowberry) 797
Chionodoxa (Glory-of-the-Snow) 797
Chirita 798
Chives (Allium schoenoprasum) 798
Chloranil 17
Chlorine Injury 420
Chlorogalum (Soap-Plant) 798
Chloroneb 18
Chloropicrin 18
Chloroscypha
chloromela 1067
juniperina 924
Chlorosis 420, 421, 703, 704, 710, 711, 720, 723, 738, 744, 749, 768, 777, 782, 785, 792, 804, 818, 821, 829, 850, 859, 863, 868, 896, 904, 914, 937, 942, 971, 974, 981, 985, 991, 992, 999, 1001, 1003, 1005, 1027, 1029, 1031, 1034, 1038, 1046, 1049, 1053, 1079, 1087, 1093, 1118
Chlorothalonil 18
Chlorotic
Peacock Pattern 1094
Ring Spot 770
Spot 1039
Streak 923
Chlorotic Dwarf 1021
Chlorotic Mottle 1095
Chlorpicrin 28
Choanephora 166
americana 826, 995
compacta 968
conjuncta 999, 1015

cucurbitarum 166, 743, 821, 859, 983, 1011, 1015, 1086, 1101, 1126
infundibulifera 166, 901, 922, 1078
persicaria 1001
Choanephora sp. 1144
Choanephoraceae 51
Chocolate Leaf Spot 308
Chokeberry (Aronia) 798
Chokecherry (Prunus virginiana) 798
Chondropodium 229
pseudotsugae 229, 838
Chondrostereum
purpureum 528
Christie's Spiral Nematode 409
Christie's Stubby Root Nematode 409
Christmas Berry (Heteromeles arbutifolia) 799
Christmas Cactus (Zygocactus truncatus) 799
Christmas Rose (Helleborus niger) 799
Christmasberry
Scab 573, 574
Chrysanthemum
(Dendranthema grandiflora) 800
Aspermy 621
B Carlavirus 622
Chlorotic Mottle Viroid 621, 801
Flower Distortion 621, 801
Foliar Nematode 387
Leaf Spot 321, 359
Mosaic 622, 801
Ring Spot 622, 801
Rosette 622, 801
Rust 566
Stunt 801, 802
Stunt Viroid 622
Chrysomyxa 537
arctostaphyli 537, 747, 1084
cassandrae 716
chiogenis 537, 797
empetri 537, 820, 1084
ilicina 537, 904
ledi 537, 932, 1084
ledi var. cassandrae 537, 790, 1084
ledi var. groenlandici 537
ledi var. rhododendri 537, 1049
ledicola 537, 932, 1084
moneses 537
piperiana 537, 1049, 1084
pirolata 537, 966, 1084
roahensis 1049
roanensis 1084
weirii 538, 1084
Chrysopsis (Golden Aster) 801
Chytridiomycota 47
Ciberinia
camelliae 209
Ciboria 166
acerina 166
carunculoides 166, 972
Ciborinia 167, 315
acerina 953
bifrons 1031
candolleana 980
confundens 1031
erythronii 167, 849
foliicola 1137
gracilipes 949
gracilis 167, 849
seaveri 316
trillii 1114
violae 1127
whetzelii 315
wisconsinensis 1137
Cimicifuga (Bugbane, Black Cohosh) 801
Cinchona 801
Cineraria
(Senecio) 801
Mosaic 622, 802
Cinnamon-Tree (Cinnamomum zeylandicum) 802
Cintractia 583
luzulae 1140
Cirsium (Plumed Thistle) 802
Cissus 802

Citrus
Blast 117
Blight 206
Canker 123
Enation 805
Enation – Woody Gall Luteovirus 623
Exocortis 805
Exocortis Viroid 623
Fruits (Grapefruit, Lemon, Lime, Orange) 803
Leaf Rugose 805
Leaf Rugose Ilarvirus and Citrus Variegation Ilarvirus 623
Leprosis 805
Leprosis Rhabdovirus 623
Mildew 447
Nematode 411
Psorosis 805
Psorosis Complex: Citrus Leaf Rugose Ilarvirus, Citrus Ringspot Virus, Citrus Variegation Ilarvirus 623
Ring Nematode 391
Ringspot 805
Ringspot Virus 624
Scab 597
Septoria Spot 360
Stubborn Disease 624, 803
Tatter Leaf 805
Tatter Leaf Cappillovirus 624
Tristeza 805
Tristeza Closterovirus 624
Variegation 805
Vein Enation 624, 805
Xyloporosis 624, 805
Yellow Vein 625, 805
Cladochytrium graminis 886
Cladochytrium replicatum 1114
Cladocolea cupulata 1020
Cladode Rot 461, 475
Cladosporium 167, 219, 316, 373, 571
(Heterosporium) 333
allii 333
aromaticum 1096
arthrinioides 759
astericola 880
beijerinckii 168
brevipes 981
bruneo-atrum 571
brunneolum 920
carpophilum 571, 711, 724, 793, 976, 1002, 1027
caryigenum 571
cladosporioides 167, 1092
cladosporioides f. sp. pisicola 572
colocasiae 316, 843
coreopsidis 572, 812
cucumerinum 572, 821, 960, 1087, 1134
echinulatum 316, 333, 780
effusum 903, 1008
epiphyllum 316, 942
erianthi 1028
fasciculatum 948
fulvum 373, 1111
fuscum 1052
gloeosporioides 1060
gramineum 740
herbarum 219, 373, 703, 737, 744, 780, 792, 859, 875, 877, 887, 918, 919, 936, 981, 1003, 1011, 1112, 1126
heugelinianum 764
iridis 333
lysimachiae 943
macrocarpum 373, 1082
oxycocci 817
oxysporum 316, 803, 1111
paeoniae 219, 1009
pisicola 573, 999
triostei 910
variabile 333, 1082
vignae 747
Cladosporium sp. 729, 732, 865, 884, 921, 930, 937, 1006, 1027, 1050, 1052, 1084, 1099, 1105, 1128, 1131
Cladosporium spp. 721, 786
Clarkia 805

Clasterosporium
cornigerum 909
Clasterosporium sp. 719
Clausena (Wampi) 805
Clavariaceae 61
Clavibacter
agcopyri 101
cassiicola 1029
fascians 101, 780, 800, 871, 892, 896, 915, 975, 1015, 1016, 1040, 1069, 1091, 1100
flaccumfaciens 101, 743, 1078
humiferum 101, 1030
ilicis 903
michiganense 101, 763, 766, 789, 828, 841, 890, 923, 1011, 1033, 1060, 1110, 1114
michiganense subsp. michiganense 101
michiganense subsp. sepedonicum 102
poinsettiae 102, 1029
sepedonicum 102, 748, 1033
xyli subsp. cynodontis 103, 885
xyli subsp. xyli 103
Claviceps
africana 924
cynodontis 886
microcephala 886
purpurea 741, 886, 1028, 1050
Clavicipitaceae 55
Claytonia (Spring Beauty) 806
Clematis
Leaf 306
Leaf Spot 321
Clematis (including Virgins-Bower) 806
Cleome (Spider-Flower) 806
Clerodendron Zonate Ring Spot 625
Clerodendrum (Glorybower) 807
Clethra (Sweet Pepperbush, White-Alder) 807
Climacoden septentrionalis 528
Clinopodium (Basil-Weed) 807
Clintonia 807
Clitocybe
monadelpha 468, 1001, 1039
olearia 981, 1025
parasitica 903, 1001
Root Rot 467, 468
tabescens 468, 700, 704, 705, 721, 724, 726, 737, 738, 740, 770, 774, 776–778, 784, 786, 790, 791, 794, 797, 804, 811, 812, 815, 818, 825, 836, 842, 845, 849, 850, 877, 884, 891, 893, 902, 904, 908, 913, 921, 922, 925, 944, 946, 949, 951, 954, 981, 983, 992, 993, 996, 1001, 1008, 1018, 1021, 1025, 1028–1030, 1039, 1053, 1062, 1090, 1092, 1096, 1099, 1100, 1105, 1109, 1118, 1126, 1135
Clivia 807
Closterovirus 71
Cloudy Spot 498, 1111
Clove Rot 503
Clover 1000
(Alsike) Mosaic = Clover Yellows Vein Potyvirus 625
(Red) Vein Mosaic Carlavirus 625
(Trifolium incarnatum, T. pratense, T. repens, T. stoloniferum, T. subterraneum, T. vesiculosum) 807
Club Leaf 625
Cyst Nematode 398
Dodder 274
Proliferation 131, 1092
Proliferation Subgroup A Phytoplasma 745
Wound Tumor Phytoreovirus 626
Yellow Edge 1092
Yellow Edge Phytoplasma 896
Yellow Mosaic 808, 1124
Yellow Mosaic Potexvirus 625
Yellow Vein 745, 783, 889, 1029, 1138
Yellow Vein Mosaic 626
Club Root 268
Clypeolella leemingii 867

Clypeosphaeriaceae 56
Cobb's Meadow Nematode 405
Cobb's Ring Nematode 391
Cobb's Spiral Nematode 394
Cobb's Stubby Root Nematode 410
Coccoloba (Sea-Grape, Dove-Plum) 808
Coccomyces
  hiemalis 318, 792, 793
  kerriae 318, 927
  lutescens 318, 792, 794
  prunophorae 318, 1026
  tumidus 714
Coccomyces sp. 723, 764
Cocklebur (Xanthium) 808
Cockscomb (Celosia argentia) 808
Cocksfoot Streak 889
Cocksfoot Streak Potyvirus 626
Cocoa (Theobroma cacas) 808
Cocoa-Plum (Chrysobalanus) 809
Cocoyam (Xanthosoma) 809
Codonanthe 809
Coffee-Berry (Rhamnus californicus) 809
Coleosporium 538
  apocyanaceum 538, 715, 1022
  aridum 761
  asterum 538, 734, 735, 801, 848, 867, 880, 890, 1022, 1068
  campanulae 776, 943, 1022, 1080
  crowellii 538, 1021, 1022
  delicatulum 538, 880, 1022
  domingense 1028
  elephantopodis 1022
  helianthi 538, 729, 897, 1022, 1097
  inconspicuum 812, 1022
  ipomoeae 539, 773, 826, 922, 968, 969, 1022, 1102
  jonesii 539, 824, 881, 1022
  lacinariae 539
  laciniariae 936, 1022
  madiae 956, 1022, 1097
  mentzeliae 539
  minutum 539, 863, 1022
  occidentale 1067
  pacificum 539
  pinicola 539, 1022
  plumeriae 1028
  senecionis 1022, 1067
  sonchiarvensis 1022
  steviae 536
  terebinthinaceae 1022, 1071
  tussilaginis 539
  vernoniae 539, 919, 1022
  viburni 539, 1126
  viguierae 1124
Coleus 809
  Mosaic 809
  Mosaic = Cucumber Mosaic Cucumovirus 626
Collar Rot 179, 456, 475, 484, 491, 509, 511, 720
Collards 810
Collecephalus hemerocalli 828
Colletotrichum 86, 167, 230, 318, 468
  acutatum 86, 167, 230, 318, 468, 711, 721, 836, 884, 953, 1000, 1092, 1118, 1135
  acutatus 1094
  antirrhini 86, 1073
  atramentarium 86, 1033, 1112
  azaleae 738
  bletiae 87
  capsici 87, 468, 1011, 1012
  cinctum 987
  circinans 468, 979, 985, 1069
  coccodes 87, 318, 468, 703, 964, 1012, 1078, 1112
  crassipes 713
  dematium 87, 167, 874, 1081, 1126
  dematium f. sp. spinaciae 87
  dematium f. sp. truncata 87, 318, 837, 1096
  dematium var. truncata 1109
  dioscoreae 1141
  elastica 318, 859
  erumpens 87

erythrinae 1024
falcatum 1028
fragariae 87, 944, 1092
fructus 721
fuscum 87, 864
gloeosporioides 87, 167, 318, 468, 486, 718, 742, 771, 772, 778, 779, 785, 824, 835, 836, 853, 855, 858, 859, 884, 922, 942–944, 965, 983, 987, 993, 995, 997, 1012, 1024, 1030, 1054, 1089, 1091, 1092, 1138
glycines 1109
gossypii 1109
graminicola 87, 761, 789, 1109
graminicolum 885
griseum 850
helianthi 1097
hibisci 901, 983, 1055
higginsianum 87, 796, 1119
jussiaeae 1134
lagenarium 88, 739, 783, 791, 797, 882, 959, 965, 1086, 1133
liliacearum 88, 1076, 1143
lilii 88, 469, 938
lindemuthianum 88, 743, 746
malvarum 88, 703, 905, 931, 1070
nigrum 469, 1012
omnivorum 88, 733
orbiculare 88, 1133
peckii 1115
philodendri 1016
phomoides 89
pisi 89, 998, 1100
pleosporioides 994
primulae 1038
rhexiae 958, 1048
schizanthi 89, 765
silphii 1071
smilacis 1072
solitarium 880
sordidum 968
spinaciae 1081
spinacicola 1081
sublineola 89
sublineolum 1136
trichellum 89, 305, 1109
trifolii 944
truncatum 89, 743, 841, 933, 1078
vermicularioides 939
violae-tricoloris 89, 994, 1127
Colletotrichum sp. 89, 728, 732, 733, 737, 742, 766, 780, 796, 805, 833, 839, 908, 913, 938, 948, 967, 993, 1010, 1016, 1030, 1050, 1066, 1105, 1114, 1124, 1126
Colletotrichum spp. 841
Collinsia (Blue-Lips, Blue-Eyed Mary) 810
Collinsonia (Horse-Balm) 810
Collomia 810
Collybia
dryophila 832
velutipes 469, 785, 845, 910, 939, 954, 1031, 1117
Coltsfoot (Tussilago) 810
Columbine
Leaf Spot 310
Root-Knob Nematode 402
Columbine (Aquilegia) 810
Columbo (Frasera) 811
Columnea 811
Comandra Blister Rust 540
Commelina
Diffusa Potyvirus and Commelina Mosaic Potyvirus 626
Mosaic 811
Commelina (C. diffusa) 811
Common
Bunt 586
Dodder 274
Scab 575
Comovirus 71
Completoria complens 855
Confederate-Jasmine (Trachelospermum) 811
Coniella
(Coniothyrium) 470

diplodiella 470
granati 1030
Coniophora 469
corrugis 470
puteana 470, 825, 861, 930
Coniophora corrugis 861, 925
Coniosporium
fairmani 1087
Coniothecium
eriodictyonis 1142
richardiae 774
Coniothrium
fuckelii 1000
Coniothyrium 230, 318
agaves 789
cephalanthi 766
concentricum 319, 789, 1142
diplodiella 470, 884
fuckelii 185, 230, 1128
hellebori 319, 799
negundinis 759, 953
olivaceum 948
pirinum 817
pyrina 319
pyrinum 719, 894, 1005
rhois 1096
rosarum 231, 1052
ulmea 844
wernsdorffiae 231, 1052
Coniothyrium sp. 756, 948, 1000, 1009
Coniothyrium spp. 844
Conophilis americana 747
Conoplea globosa 264
Copper
Acetate 18
Ammonium Carbonate 18, 26
Carbonate 18
Compounds 18
Deficiency 421
Fixed 26
Hydroxide 18, 26
Oxide 18
Oxychloride 18
Spot 327, 355
Spray Injury 421
Sulfate 19, 26
Copper Spray Injury 904
Coprinus 470
urticicola 470, 1006
Coral Spot 251
Coral-Bells 811
Coralberry
(Symphoricarpos orbiculatus) 812
Cordia 812
Coreopsis (Tickseed) 812
Coriander
Feathery Red Vein 813
Feathery Red Vein Nucleorhabdovirus 626
Coriander (Coriandrum) 813
Coriolus versicolor 719
Cork 421, 720, 1005
Corky Dry Rot 483
Corky Rot 121
Corky Scab 575
Corm Rot 160, 463, 482
Corn
(Sweet) Mosaic 627
Cyst Nematode 398
Leaf Fleck 626, 814
Meadow Nematode 406
Measles 352
Mosaic 814
Pox 352
Root Rot 485
Rust 565
Smut 589
Stunt 131, 133, 814
Sweet (Zea mays var. saccharata) 813
Corn-Marigold (Chrysanthemum segetum) 814
Corncockle
(Agrostemma) 814
Corticium 167, 470
centrifugum 471, 721
falactinum 1126
fuciforme 471, 888

galactinum 471, 712, 721, 754, 807, 832, 836, 904, 922, 946, 971, 981, 1096
koleroga 167
laetum 718
microsclerotia 167
radiosum 471
salmonicolor 167, 718, 858, 1004
stevensii 167
vagum 167
Corydalis 814
Corynebacterium
agropyri 103
humiferum 103
Coryneform Group Mycobacteriaceae 101
Coryneliaceae 54
Corynespora 319, 471
cassiicola 471
Corynespora cassiicola 319, 738, 784, 859, 914, 940, 945, 983, 1029, 1038, 1068, 1078, 1079, 1109, 1111, 1127, 1133
Coryneum 168
asperulum 825
beierincki 784
berckmansii 168, 726, 727, 825
Blight 168, 169
Canker 232
cardinale 232, 726, 727, 825, 916, 925
carpophilum 168, 711, 723, 792, 976, 1000, 1026
foliicola 232, 719, 1005
japonicum 980
microstictum 168, 756, 1088
negundinis 759
rhododendri 1049
tumoricola 844
Cosmopolitan 463
Cosmos 815
Cotoneaster 815
Cotton
(Gossypium) 815
Leaf Curl Bigeminivirus 627
Root Rot 506, 508
Cotton Root-Knob Nematode 403
Cottony Rot 526
Coursetia 816
Covered Kernel Smut 586
Covered Smut 589
Cowania 816
Cowpea
(Vigna sinensis) 816
Aphid-Borne Mosaic 816
Canker 128, 130
Chlorotic Mottle 745, 1004, 1095
Mosaic 1080
Mosaic Comovirus 627
Severe Mosaic 816
Cowpea Mosaic 747, 903
Crabapple
Flowering (Malus) 816
Cracked Stem 422, 787
Crackneck 800
Cranberry
(Vaccinium, subgenus Oxycoccus) 817
Bitter Rot 487
Blotch Rot 455
Early Rot 487, 488
End Rot 487
False Blossom 627, 818
Hard Rot 496
Ring Spot 818
Rose Bloom 290
Crape-Myrtle
(Lagerstroemia) 818
Powdery Mildew 453
Crassula 818
Creeping Zinnia
(Sanvitalia procumbens) 819
Creosote Bush (Larrea) 819
Cribropeltis 286
Cribropeltis citrullina 286, 1133
Criconella
xenoplax 390

Criconema 390
civellae 390, 803
decalineatum 390
mutabile 723
spinalineatum 390
Criconema sp. 945
Criconemella
xenoplax 887, 1057
Criconemoides
annulatum 391, 981
citri 391, 803
crotaloides 391, 838, 1031
curvatum 391, 780, 887
cylindricum 391, 1003
komabaensis 391, 775
lobatum 391, 887, 1021
mutabile 391, 1034
ornatum 391, 887
parvum 391, 887
rusticum 391, 887
similis 391, 1001, 1021
teres 391, 981
xenoplax 391, 772, 883, 887, 1001
Criconemoides (Genus dubium) 391
Criconemoides sp. 954, 1053
Crimson
Clover Latent 808
Clover Latent Nepovirus 628
Crinkle 809, 1054
Crinum 819
Cristulariella 319
depraedans 320
depraedens 954
moricola 320, 883, 893, 901, 1111
pyramidalis 708, 714, 720, 744, 759, 793, 836, 883, 901, 948, 954, 976, 1008, 1064, 1118, 1126, 1130
pyramudates 756
Cristutariella
pyramidalis 1025
Crocus 819
Cronartium
appalachianum 540, 1022
coleosporioides 540, 989, 990, 1022, 1140
comandrae 540, 763, 1021
comptoniae 540, 990, 1022, 1098, 1099
conigenum 541, 981, 1021
filamentosum 1022
fusiforme 981, 1022
harknessii 541
occidentale 541, 824, 881, 1022
quercuum 541, 941, 981, 1022
quercuum f. sp. fusiforme 541, 1022
ribicola 541, 823, 824, 881, 1023
stalactiforme 544, 1022
strobilinum 544, 981, 1021
Cronartium (Causing Blister Rusts) 539
Crook-Neck 871
Crossonema 391
Crossonema sp. 391, 790
Crotalaria (C. retusa) 819
Croton (Codiaeum) 819
Croton (Croton) 820
Crowberry
(Empetrum) 820
Crown
and Petiole Spot 318
and Root Rot 506, 511
Canker 236, 259
Elongation 1010
Gall 98
Rot 180, 190, 192, 461, 480, 483, 489, 498, 503, 512, 521, 522, 525, 527
Crown and Collar Rot 463
Crown Rust 561
Crown Vetch (Coronilla varia) 820
Crown-Headed Lance Nematode 398
Cryphonectria 232
cubensis 240
parasitica 176, 232, 980
Cryphonectria (Endothia) 176
Cryptantha 820
Cryptanthus 820

Cryptochaete 472
(Corticium) polygonia 472
Cryptocline 169
betularum 327
cinerescens 169, 980
taxicola 1142
Cryptococcus
fagesuiga 747
laurentii 883
Cryptodiaporthe 233
aculeans 1096
castanea 233, 794
corni 836
macounii 1082
salicella 233
salicina 1137
Cryptomeria 820
Cryptomyces 233
maximus 233, 988, 1137
Cryptomycina 320
pteridis 320, 854, 857
Cryptospora 169
longispora 169, 213, 726
Cryptosporella 233
umbrina 234, 1052
viticola 234, 883
Cryptosporiopsis (Glutinium) 245
Cryptosporiopsis pruinosa 245
Cryptosporium 235
macrospermum 860
minimum 235, 1052
pinicola 236
Cryptostictis 170, 320, 836
arbuti 320, 932, 948, 952
mariae 1049
paeoniae 1010
violae 1127
Cryptostictis sp. 170, 935
Crytodiaporthe
aculeans 233
Cucumber
(Cucumis sativus) 821
Blight 151
Mosaic 710, 713, 740, 745, 749, 765, 772, 778, 786, 787, 797, 808, 811, 814, 822, 827, 830, 831, 833, 842, 845, 849, 852, 866, 871, 872, 876, 882, 891, 901, 915, 934, 938, 956, 960, 962, 965, 969, 974, 978, 998, 1010, 1012, 1015, 1038, 1058, 1074, 1082, 1087, 1098, 1112, 1121, 1125, 1127, 1138, 1144
Mosaic Cucumovirus 628
Scab 572
Wilt 110, 689
Cucumovirus 71, 856
Cucurbit
Leaf Crumple 1134
Leaf Crumple Begomovirus 629
Leaf Curl 822, 961, 1087
Leaf Curl Begomovirus 628
Yellow Stunting 961
Yellow Stunting Crinivirus 629
Yellows 1094
Cucurbitariaceae 55
Cufraneb 19
Culvers-Root (Veronicastrum) 822
Cumminsiella 544
mirabilissima 544, 950
sanguinea 741
texana 544, 950
wootoniana 950
Cunninghamia 822
Cuphea 822
Curl-Stripe Disease 938
Curly Top Virus (Beet) 779
Currant
(Red) Mosaic = Tomato Ringspot Nepovirus 629
(Ribes spp.) 822
Flowering (Ribes) 823
Mosaic 823
Current
Anthracnose 97
Cane Blight 155
Nematode 389

Curtobacterium
flaccumfaciens pv. flaccumfaciens 103
flaccumfaciens pv. poinsettia 103
flaccumfaciens subsp. flaccumfaciens 743
Curvularia 170, 298, 1007
crepini 854
cymbopogonis 170, 919
Disease 170
geniculata 761, 767, 885
inaequalis 817, 885, 1004, 1082, 1119
lunata 170, 875, 885, 1012
trifolii 821, 1086
Curvularia sp. 298, 789, 914, 945, 1028, 1101
Curvularia spp. 1145
Cuscuta
americana 274, 803
arvensis 800, 942, 960, 982, 1124
californica 274
campestris 929
compacta 709, 766, 798, 904, 917, 947, 1013, 1125, 1135
coryli 274
cuspidata 867
epithymum 274
exaltata 274, 761, 904, 965, 1047, 1096
glomerata 936
gronovii 274, 766, 821, 857, 923, 953, 987, 1045, 1048, 1138
indecora 274, 777, 800, 820, 983, 984, 1052, 1100, 1126
paradoxa 274, 1052
pentagona 274
planifera 274
subinclusa 772
Cuscuta sp. 731, 738, 756, 775, 779, 782, 788, 800, 812, 815, 834, 881, 886, 912, 920, 942, 975, 996, 999, 1011, 1033, 1038, 1059, 1074, 1080, 1091, 1097, 1098, 1141
Cuscuta spp. 272, 734, 748, 841, 879, 980, 985, 1015, 1110, 1137
Cuticle Crack 1111
Cuticularia ilicis 904
Cutospora Canker 237
Cyathus stercoreus 284, 886
Cycad, Sago-Palm (Cycas) 824
Cyclamen 824
Leaf 179
Cyclaneusma (Naemacyclus) 380
Cyclaneusma niveum 380
Cycloclonium oleaginum 984
Cycloconium 320
oleaginum 320
Cycloheximide 19
Cylindrobasidium corrugum 470
Cylindrocarpon 137, 236, 472
cylindroides 236
destructans 472
didymium 236, 719
liriodendri 472
obtusisporum 137, 883
radicicola 707, 738, 749, 938, 975
Cylindrocarpon sp. 756, 925
Cylindrocephalum sp. 746
Cylindrocladium 171, 236, 321, 472
avesiculatum 171, 321, 904, 935
Black Rot 472
Blight 171
canadense 1084
clavatum 171, 321, 472, 726, 752, 758, 1021
colhounii 321, 758
crotalariae 472, 927, 1004, 1079, 1118
floridanum 737, 936, 1002, 1048, 1103, 1118
heptaseptatum 472, 856
liriodendri 1117
macrosporium 993
parasiticum 472, 784, 903, 1004
pauciramosum 472, 896, 974
pteridis 321, 472, 854–857

scoparium 171, 236, 472, 737, 898, 904, 930, 936, 1019, 1021, 1031, 1048, 1052, 1083, 1094, 1099, 1103, 1117, 1118
scorparium 473
sesami 1068
Cylindrocladium sp. 949, 1047, 1131
Cylindrosporium 171, 321
acori 1099
angustifolium 1142
ariaefolium 906
artemisiae 1059
betulae 321, 752
brevispina 894
castaneae 794
ceanothi 786
celtidis 892
cercosporioides 1117
chrysanthemi 321, 800, 827
circinans 755
clematidinis 321
clematidis 806
crataegi 894
dearnessi 908, 909
defoliatum 171, 892
eminens 866, 1098
eryngii 849
ficariae 1044
filipendulae 1083
fraxini 731
gei 873
geranii 872
glyceriae 886
gnaphalicola 877
griseum 171, 1076
guttatum 1089
heraclei 900
hirtella 980
humuli 908
juglandis 171, 1130
kelloggii 980
lippiae 940
lupini 945
magnusianum 1089
microspilum 980
montenegrinum 1115
negundinis 759
nuttallii 799, 989
officinale 1076
orthosporum 752
parkinsoniae 996
passaloroides 714, 917
pastinacae 997
phaceliae 772
populinum 337
rhamni 763
ribis 823
rubi 754, 1045
salicinum 321, 1137
scrophulariae 860
smilacinae 1077
smilacis 1072
solitarium 942
stachydis 1088
steironematis 943
tenuisporium 844
thalictri 958
tradescantiae 1114
triostei 910
veratrinum 1123
vermiforme 709, 896
violae 1127
ziziae 1144
Cylindrosporium sp. 321, 764, 853, 956, 958, 1096
Cylindrosporium spp. 899, 1082
Cymbidium
Mosaic Potexvirus 629
Cymbidium Mosaic 987
Cymoxanil 19
Cynoglossum (Hounds-Tongue) 825
Cyphella marginata 1000
Cyphellopsis anomala 263
Cypress
Root Rot 512
Cypress (Cupressus) 825
Cypress-Vine (Quamoclit) 826
Cypripedium Leaf Spot 307

Cyproconazole 19
Cyprodinil 19
Cyrilla (Leatherwood) 826
Cyst Nematode 397
Cystospora
  pinicola 965
Cystotheca lanestris 450
Cytophoma pruinosa 731
Cytorhabdovirus 72
Cytospora 236, 322
  abietis 236, 860
  amorphae 714
  annularis 731
  Canker 237
  cenisia 825
  chrysosperma 237, 798, 842, 970, 980, 1031
  cylindroides 860
  gleditschiae 906
  kunzei 237, 1083
  leucosperma 237
  leucostoma 237, 792, 970
  ludibunda 844
  massariana 970
  microspora 970
  nivea 237
  pinastri 860, 1019
  pruinosa 236
  rubescens 970
  sambucicola 842
Cytospora sp. 237, 322, 709, 731, 794, 836, 838, 898, 969, 972, 1007, 1017, 1018, 1052, 1120, 1130
Cytospora spp. 237, 719, 723, 747, 953, 1005
Cytosporina
  ludibunda 844
Cytosporina Dieback 243
Cytovirin 29
Cyttariaceae 57

Dactylaria 322
  higginsii 322, 979
Daedalea 473
  ambigua 907, 1014, 1132, 1137
  confragosa 473, 710, 721, 845, 866, 895, 904, 909, 939, 1064, 1100, 1119, 1131, 1137
  elegans 907
  extensa 1117
  juniperina 925
  quercina 473, 981, 1131
  unicolor 473, 708, 710, 714, 752, 764, 942, 1117, 1119
Daedalea confragosa 836
Daedalea spp. 731, 748, 892, 903, 954, 1025, 1031
Daedaleopsis confragosa 473
Dagger Nematode 412
Dahlia 826
  Leaf Smut 584
  Mosaic 827
  Mosaic Caulimovirus; Stunt 629
  Oakleaf 629
  Ring Spot 629
Daisy
  Oxeye (Leucanthemum vulgare) 827
Daldinia 473
  concentrica 474, 731, 805, 845, 909, 940, 949, 954, 981, 1014
  occidentalis 710
  vernicosa 836, 904, 981, 1064, 1117
Daldinia spp. 748
Dalibarda (Dewdrop) 827
Damping-Off 303, 359, 458, 502, 513, 519–522
Dandelion
  (Taraxacum) 827
Daphne 828
  Leaf Spot 337
Dapple Apple 722
Dasheen Mosaic 774, 843
Dasheen Mosaic Potyvirus 630
Dasyscyphus 238
  agassizi 238
  calycina 238
  ellisiana 238, 838, 1019

gaultheriae 1060
pseudotsugae 238, 838
resinaria 238, 860
willkommii 238, 879
Dasyscyphus pini 1019
Datura 828
Davisomycella ampla 378
Daylily (Hemerocallis) 828
Dazomet 19, 26, 28
DDT Injury 422
Dead-Arm Disease 234
Decline 133, 391, 409, 491, 501, 504, 533, 722, 954, 1025, 1099
Decline Disease 500
Decumaria 828
Delayed Maturity 133
Delphinella 171
(Rehmiellopsis) 207
balsameae 171, 207, 860
Delphinium
Black Spot 116
Blackleg 108
Ring Spot 630, 830
Delphinium (Larkspur) 829
DeMan's Meadow Nematode 406
Dematiaceae 63
Dematium spp. 818
Dematophora
necatrix 859
Dematophora sp. 881
Demorphotheca 830
Dendrophoma 172
obscurans 172, 197, 1092
Dendrophoma sp. 756
Dendrothele acerina 224
Dermatea
balsamea 898
Dermea
acerina 239
balsamea 239
pseudotsugae 239, 838
Dermea (Dermatea) 239
Desert Bird Of Paradise (Caesalpinia) 830
Desert-Candle (Eremurus) 830
Desert-Plume (Stanleya) 830
Desert-Rose (Adenium obesum) 831
Desert-Willow (Chilopsis) 831
Desmella 545
aneimiae 545
superficialis 854
Desmodium
Mosaic 903
Mosic Potyvirus 630
Yellow Mottle 891, 903
Yellow Mottle Tymovirus 630
Desmodium (Arrowleaf) 831
Deutzia 831
Devils-Club (Oplopanax) 831
Devilwood (Osmanthus americanus) 831
Dewberry (Rubus) 832
Diachea leucopodia 1094
Dianthovirus 72
Dianthus (Garden Pinks) 833
Diapleella coniothyrium 184, 249
Diaporthe 172, 240, 474
(Phomopsis) vaccinii 756
arctii 172, 829
batatatis, meridionalis 1078
batatis 1102
Blight 172
caulivora 1078
citri 474, 804, 893, 929
cubensis 240, 849
eres 240, 820, 904
helianthi 240, 1097
oncostoma 240, 942
pernisiosa 719
phaseolorum 172, 474, 744, 1012, 1078, 1112
phaseolorum caulivora 240
phaseolorum var. cauliflora 968
phaseolorum var. caulivora 173, 706, 713, 783, 899, 916, 921, 923, 1048, 1070, 1085
phaseolorum var. sojae 173
pruni 240

sojae 1003, 1078
stewartii 815
vaccinii 173, 756, 817, 818
vexans 173
Diaporthe spp. 762
Diatrypaceae 56
Dibotryon
morbosum 136, 723, 792, 798, 1026
symphoricarpi 1139
Dichaena quercina 980
Dichlofluanid 19
Dichloropropene 28
Dichomitus squalens 514
Dichondra (Lawn-Leaf) 833
Dichotomophora 173
lutea 173
Dichotomophthora 240, 474
indica 1033
portulacae 240, 474, 1033
Dichotomophthoropsis 322
nymphaearum 322, 1132, 1134
nymphaerum 1132
Dicloran 19
Didymaria 322
alismatis 728
conferta 1140
didyma 322, 716, 1044
Didymascella
(Keithia) 174
chamaecyparissi 790
thujina 174, 726
tsugae 174, 177, 898
Didymella 174
applanata 174, 753, 832, 1045
bryoniae 175, 1133
ligulica 154
lycopersici 307
sepincoliformis 240, 1052
Didymellina 322
macrospora 322, 754, 918
ornithogali 322, 1089
poecilospora 323
Didymosphaeria 175
oregonensis 709
populina 175
Didymosporina aceris 337, 953
Didymosporium 324
arbuticola 324, 948
Dieback 90, 91, 96, 155, 199, 200, 225, 226, 229, 230, 233, 236, 237, 240, 241, 243, 246, 249–252, 257–259, 264, 266, 267, 422, 486, 686, 736, 868, 1131
Wilt 877
Dieffenbachia 833
Leaf Spot 124, 129, 310
Diervilla (Bush Honeysuckle) 834
Difenoconazole 19
Digitaria (Large Crabgrass) 834
Dill
Root Rot 484
Dill (Anethum) 834
Dilophospora 324
geranii 324, 872
Dimanin A 26
Dimerium
alpinum 1009
juniperi 143, 924
Dimerosporium 140
abietis 140, 860
ellissi 912
hispidulum 140, 969
magnoliae 948
pulchrum 140, 730, 811, 835
robiniae 140, 708
tropicale 140
Dimethirimol 19
Dimethomorph 19
Dimple 1034
Dimple skin 1034
Diniconazole 19
Diodia 834
Vein Chlorosis 834
Vein Chlorosis Closterovirus 630
Diplocarpon 144, 299
earliana 1093

earlianum 299
mespili 177
rosae 144, 1052, color plate 10
Diplocarpon (Fabraea) 177
Diploceras
hypericum 1060
Diplodia 175, 241, 475, 804
acerina 359
ailanthi 708
amorphae 714, 917
asparagi 732
bambusae 739
camphorae 241, 777
circinans 1142
Collar 475
Collar and Root Rot 475
coluteae 175, 755
Corn Ear Rot 475, 476
crataegi 1040
gossypina 175, 1004, 1019
infuscans 241, 731
juglandis 241, 1130
laeliocattleyae 987
longispora 175, 794, 980
mutila 241, 878, 925
natalensis 241, 475, 708, 777, 783, 791, 804, 821, 841, 859, 893, 927, 960, 985, 1001, 1014, 1037, 1087
opuntia 475
opuntiae 770
persicae 1001
phoenicum 475, 992
pinastri 475
pinea 786, 838, 1019, 1084, 1120
quercina 241, 980
radicicola 840
rhododendri 324
Rot 508, 509
salicina 1136
sarmentorum 175
sarothamni 762
sophorae 241, 1077
sycina 241, 858
theobromae 475, 737, 1102, 1112
tubericola 475, 777
tumefaciens 249
viticola 884
zeae 475, 813
Diplodia sp. 241, 726, 815, 843, 870, 889, 904, 952, 993, 995, 1025, 1099
Diplodia spp. 843, 1026, 1052, 1133
Diplodina 324, 476
delphinii 829
persicae 476
Diplosporonema delastrei 337
Diplotheca
(Stevensea) 325
tunae 142
wrightii 325, 769, 770
Diplotheca sp. 770
Discella 241
carbonacea 241, 1137
microsperma 241
ochroleuca 337
Discocainia treleasi 898
Discochora philoprina 349
Discogloeum concentricum 326
Discohainesia oenotherae 346, 756, 817, 835, 867, 869
Discola fraxinea 866
Discosia
artocreas 899, 1049, 1099, 1139
bubaki 847
maculicola 1138
Discosporium populeum 242
Discostroma corticola 246
Discula 90, 176
campestris 90, 953
destructive 90, 835
fraxinea 90, 730
quercina 176, 980
Discula sp. 835
Diseased Inflorescence 154
Disinfectant 11
Dithianon 19
Dittany, Stonemint (Cunila) 834
Ditylenchus 392
(Sychnotylenchus) gallicus 393

destructor 392, 826, 1034
dipsaci 392, 748, 787, 797, 810, 827, 829, 855, 865, 873, 890, 913, 914, 918, 939, 943, 946, 974, 985, 989, 996, 1009, 1010, 1017, 1038, 1043, 1044, 1061, 1065, 1079, 1093, 1101, 1103, 1106, 1109, 1116
gallicus 845
iridis 393
Dizygotheca 834
Doassansia 583
deformans 728
epilobii 583, 847
furva 728
intermedia 728
obscura 728
opaca 728
ranunculina 1045
sagittariae 728
Dodder
(Cuscuta) 835
Latent Mosaic 630
Dodecatheon (Shooting-Star) 835
Dodemorph Acetate 20
Dogbane (Apocynum) 835
Dogwood
Dwarf, Bunchberry (Cornus canadensis) 835
Flowering (Cornus florida) 835
Leaf Spot 307, 312, 360
Mosaic 836
Mosaic Nepovirus 630
Pacific (Cornus nuttalli) 837
Pagoda, Gray, Red Osier, Western Osier (Cornus spp.) 837
Spot Anthracnose 597
Dolichodorus 393
(Neodolichlodorus) obtusus 394
heterocephalus 393, 744, 787, 1011, 1111
obtusus 1008
Dolichos (Twinflower, Hyacinth Bean) 837
Dollar Spot 525
Doronicum (Leopards-bane) 837
Dorylaimus 394
Dorylaimus spp. 394
Dothichiza 242, 325
Canker 242
caroliniana 325, 756
garryae 869, 1071
populea 242, 1030
Dothidea tetraspora 762
Dothideaceae 54
Dothidella
alni 709
castanopsidis 797
parryi 789
vacciniicola 756
Dothiora 242
polyspora 242, 1031, 1137
ribesia 257
taxicola 214
wolfii 214
Dothiora (Sphaerulina) 214
Dothiorella 242, 686
berengeriana 1099
Canker 243
fraxinicola 243, 731
gregaria 992, 1130
mori 972
nelumbonis 944
phomiformis 980
quercina 243, 980
Rot 462
smilacina 1072
ulmi 243, 686, 845
Dothiorella sp. 243, 906, 972, 1025, 1052, 1117, 1137
Dothistroma 176
pini 176, 1019
septospora 1019
Double Spot 325
Douglas-Fir
Dwarf Mistletoe 370
Needle Rust 553
Root Rot 518

Douglas-Fir (Pseudotsuga) 837
Downy Mildew 275–280, 282, 283
Downy Spot 339
Draba (Whitlow-Grass) 839
Dracaena 839
  Leaf Spot 350
  Tip Blight 199
Dragonhead (Dracocephalum) 839
Drechslera
  cactivora 840
  catenaria 330, 885, 888
  dictyoides 330
  erythrospilum 331
  gigantea 886, 1136
  giganteum 331
  poae 331
  setariae 771, 955
  siccans 331
  stenacra 331
  triseptata 331
  tritici-repentis 331
Drepanopeziza ribis 97
Dropsy 352
Drought 422
Dry
  Rot 494, 498, 530, 579, 580, 984
Dry Bubble 697
Dry Root Rot 484
Du Nema 28
Duranta 839
Dusting 30
Dutch Elm Disease 683
Dutchmans-Breeches, Squirrel-Corn (Dicentra) 840
Dutchmans-Pipe (Aristolochia) 840
Dwarf Bunt 586
Dwarf Mistletoe 370, 1020
Dyschoriste 840

Ear Rot 485
Early Blight 152, 160, 164, 165
Early Rot 353
Easter Cactus (Rhipsalidopsis) 840
Eastern Dwarf Mistletoe 371
Eastern Gall Rust 541
Eastern Mistletoe 369
Echeveria 840
Echidnodella
  angustiformis 141
  rugispora 141
Echinacea (Purple coneflower) 840
Echinochloa (Barnyardgrass) 841
Echinodontium 476
  tinctorium 476
Echinodontium tinctorium 838, 861, 930
Eclipta 841
Ectostroma 325
  afflatum 801
  liriodendri 325, 1117
Edifenphos 20
Eggplant
  (Solanum melongena) 841
  Anthracnose 90, 92
  Leaf Spot 312
  Mosaic 842
Elaeagnus (Russian-Olive, Silverberry) 842
Elaphomycetaceae 58
Elder
  (Sambucus) 842
Elderberry 843
  Disease = Elderberry Carlavirus, Elderberry Latent Carmovirus 631
Elephant Hide 1034
Elephants-Ear (Colocasia) 843
Eleusine (Goosegrass) 843
Elm
  Black Spot 328, 329
  Leaf Blister 297
  Leaf Spot 327, 328, 359
  Mosaic 631
  Phloem Necrosis 131
  Yellows 845
  Zonate Canker 631
Elm (Ulmus) 844
Elsinoaceae 54

Elsinoë 596
ampelina 596, 882, 884
cinnamomi 596, 777
corni 597, 836
diospyri 597
euonymi-japonici 597
fawcettii 597, 805, 893, color plate 15
ilicis 598, 904
jasminae 598, 922
ledi 598, 932, 935, 1060
lepagei 598, 1063
leucospila 598, 776, 1106, 1107
magnoliae 598, 949
mangiferae 598, 952
mattirolianium 948
mattirolianum 598, 1094
parthenocissi 598, 1129
phaseoli 598
pini 1006
piri 598, 722, 1041
quercicola 598
quercus-falcatae 599, 981
randii 599, 903, 1008
rosarum 599, 1053
solidaginis 599, 880
tiliae 599, 940
veneta 599, 754, 832, 1046
Elytroderma 376
deformans 377, 1020, 1023
Emilia (Tasselflower, Floras-Paintbrush) 845
Enamovirus 72
Encelia 845
Encoelia (Cenangium) 228
Encoelia pruinosa 228
Encoeliopsis rhododendron 325
End Spot 422, 736
Endive
Escarole, Witloof Chicory (Cichorium) 846
Endoconidiophora
virescens 954
Endocronartium 545
harknessii 544, 545, 1022, 1023
Endomyces mali 721
Endophyllum 545
sempervivi 545, 1067
tuberculatum 545, 791, 905, 1033
Endothia 243
Canker 176
gyrosa 243, 747, 980
parasitica 794, 797, 980
Engelmannia (Engelmann Daisy) 846
Englerula carnea 1047
English
Ivy Leaf Spot 350
Ivy Scab 600
English Daisy (Bellis perennis) 847
Enterobacter cloacae 104, 874, 984, 985
Enterobacteriaceae 104
Entomosporium
Leaf Spot 177, 178
maculatum 177, 178, 916
Entyloma 583
arnicale 727
aster-seriaceanum 735
australe 796, 890
calendulae 584, 772
collinsiae 810
compositarum 584, 735, 758, 772, 848, 851, 877–879, 897, 1047, 1056, 1067, 1071
dactylidis 584
dahliae 584, 827
ellisii 584, 1082
eryngii 849
eschscholtziae 773, 1114
fuscum 1032
irregulare 888
linariae 939
lineatum 584, 1136
lobeliae 942
menispermi 968
microsporum 1045
nymphaeae 1132
polysporum 584, 867, 897, 1097

ranunculi 716, 1045
serotinum 930, 962
thalictri 958
veronicae 1125
winteri 830
wyomingense 830
Entylomella armoraciae 354
Ephelis sp. 1008
Epichloe typhina 886
Epicoccum 243, 299, 325, 476, 1007
asterinum 326, 1142
granulatum 721
neglectum 993
nigrum 243, 326, 476, 948, 960
purpurascens 713, 737, 874
Epicoccum sp. 299, 744, 756, 1079
Epifagus virginiana 747
Epigaea (Mayflower, Trailing Arbutus) 847
Epilobium (Willow-Herb, Fireweed) 847
Episcia 848
Epoxiconazole 20
Eradicant 11
Eranthemum 848
Eremothecium coryli 1112
Erigeron (Fleabane) 848
Erinose 1131
Eriophyllum 848
Erostrotheca multiformis 374, 1101
Ersiphe polygoni 826
Eruca sativa 768
Erwinia
amylovora 104, 712, 714, 718, 723, 792, 793, 798, 815, 816, 894, 916, 944, 959, 969, 1004, 1017, 1026, 1039, 1041, 1042, 1045, 1083, 1092
aroideae 770, 773, 796, 821, 843, 960, 996, 1011, 1033, 1063, 1086, 1110, 1133
carnegieana 106, 769
carotovora 732, 743, 767, 768, 770, 773, 782, 787, 800, 824, 826, 829, 839, 841, 843, 846, 853, 875, 911, 913, 918, 933, 937, 960, 984, 987, 996, 997, 1004, 1033, 1043, 1050, 1061, 1063, 1081, 1092, 1097, 1101, 1110, 1116, 1119
carotovora pv. 926
carotovora pv. atroseptica 1033
carotovora pv. carotovora 1011, 1086
carotovora pv. chrysanthemi 1029
carotovora subsp. atroseptica 107, 108
carotovora subsp. carotovora 107, 108, 969
carotovora var. carotovora 782
carotovorus 821
chrysanthemi 109, 782, 800, 1016, 1110, color plate 6
cypripedii 109, 987
cytolitica 826
dieffenbachiae 833
dissolvens 813
herbicola 109, 839, 892
nigrifluens 1130
nimipressuralis 109, 844, 980, 1136
quercina 980
rhapontica 110
rhapontici 743, 795, 933, 998, 1050
rubrifaciens 1130
stewartii 110, 813
tracheiphila 110, 821, 960, 1133
Erwinia sp. 960, 1133
Eryngium (Rattlesnake Master) 849
Erysiphe 441
aggregata 442, 709
azaleae 738
berberidis 974
cichoracearum color plate 9
convolvuli var. convolvuli 751
cruciferarum 444, 768, 1120
galeopsidis 1071, 1088
graminis 444, 762, 887
heraclei 444, 782, 787, 996
knautiae 1065
orontii 444

panax 444, 875
pisi 959
polygoni 444, 704, 714, 716, 735, 738, 741, 744, 746, 747, 749, 755, 765, 768, 773, 777, 782, 784, 796, 806, 811, 822, 829, 847, 867, 868, 870, 872, 873, 876, 889, 896, 907, 911, 914, 917, 942, 945, 957, 958, 967, 973, 982, 990, 999, 1010, 1032, 1036, 1038, 1043, 1044, 1050, 1057, 1063, 1065, 1079, 1098, 1101, 1107, 1111, 1117, 1120, 1129, 1131, 1144
sedi 1066
taurica 444
trina 444, 941, 981
unbelliferarum 997
viburni 931
Erysiphe heraclei 718
Erysiphe polygoni 734, 771, 905, 914, 964, 1120
Erysiphe polygoni var. sepulta 1042
Erysiphe sp. 444, 1111
Erysphie galeopsidis 964
Erysphie orontii 964
Erythricium salmonicolor 168
Erythrina 849
Erythronium
(Dogs-Tooth Violet, Adders-Tongue, Trout-Lily) 849
Smut 589
Erythroxylum 849
Ethylene Dibromide 28
Etridiazole 20
Euascomycetidae 52
Eucalyptus (Gum-Tree) 849
Eucharis (Amazon-Lily) 850
Eugenia 850
Euonymus
Mildew 446
Mosaic 631, 851
Euonymus (Burning-Bush, Spindle-Tree) 850
Eupatorium (Boneset, Blue Mist-flower, Dogfennel, White Snakeroot, Joe-Pye Weed) 851
Euphorbia
Mosaic 1085
Mosaic Begiminivirus 631
Trigona 851
European
Dagger Nematode 412
Larch Canker 238, 239
Mistletoe 370
Nectria Canker 252
Poplar Canker 242
Powdery Mildew 446
Euryops 852
Eustoma
(Prairie Gentian, Texas Bluebell) 852
Eutypa 243
armeniacae 723, 792, 799, 883
armeniacae syn. E. lata 243
lata 723, 792, 799, 883
Eutypa sp. 859
Eutypella
parasitica 953
stellulata 795
vitis 883
Everlasting (Antennaria) 852
Evolvulus 852
Exacum 852
Exanthema 422, 723, 804, 984, 1005, 1027
Excipulaceae 63
Exobasidiaceae 61
Exobasidium 289
burtii 289, 738, 1048
camelliae 289
camelliae var. gracilis 775
monosporum 775
oxycocci 290, 817
parvifolii 1135
rhododendri 290
symploci 290, 1100
uvae-ursi 290

vaccinii 289, 290, 715, 738, 747, 756, 784, 790, 817, 853, 912, 932, 935, 947, 948, 952, 961, 971, 1048, 1062, 1135
vaccinii-uliginosae 1048
vaccinii-uliginosi 290, 952, 970, 1135
Exophoma magnoliae 948
Exosporina fawcetti 1130
Exosporina fawcettii 803
Exosporium 326
concentricum 326, 850, 1038
fawcettii 794
glomerulosum 924
liquidambaris 364, 1099
palmivorum 364, 991, 992
phoradendri 965
Exosporium sp. 972
Exserohilum
rostratum 332, 885, 991–993
turcicum 489, 813
Exudation 1016
Eye Spot 331, 332

Fabavirus 72
Fabraea
dehnii 1036
macula 1042
maculata 714, 719, 815, 817, 944, 959, 969, 1000, 1004, 1017, 1039, 1041
maculate 178
ranunculi 1044
rousseauana 956
thuemenii 178, 894
Fabrella tsugae 178
Fairy Ring 284, 285
Fairy Ring Spot 333, 334
False Root-Knob Nematode 404
False Rust 293
False Smut 584
False Solomons Seal (Maianthemum racemosum) 1077
Farkleberry
Tree-Huckleberry (Vaccinium arboreum) 853
Fasciation 101, 103, 1034, 1074, 1111
Favolus alveolaris 477, 903
Feather Rot 518
Feijoa (Pineapple Guava) 853
Felt Fungus 263, 731
Fenaminosulf 20
Fenarimol 20
Fenbuconazole 20
Fendlera 853
Fennel (Foeniculum) 853
Fenpiclonil 20
Fenpropidin 20
Fenpropimorph 20
Fenugreek (Trigonella) 853
Ferbam 20
Fern
Adders-Tongue (Ophioglossum) 854
Anthracnose 94
Aquatic (Salvinia spp.) 854
Birds-Nest (Asplenium) 854
Bladder (Cystopteris) 854
Boston (Nephrolepis) 854
Bracken (Pteridium) 854
Brake (Pteris) 855
Christmas (Polystichum) 855
Cliff-Brake (Pellaea) 855
Holly (Cyrtomium) 855
Japanese Climbing (Lygodium japonicum) Also – Old World Climbing (Lygodium microphyllum) 855
Lady, Silvery Spleenwort (Athyrium) 856
Leaf Spot 304, 321
Leatherleaf (Rumohra) 856
Maidenhair (Adiantum) 856
Nematode 386
Osmunda (Osmunda; Cinnamon, Interrupted, and Royal Ferns) 856
Ostrich (Pteretis) 856
Polypody (Polypodium) 857
Rock (Woodsia) 858

Rock-Brake (Cryptogramma) 857
Sensitive (Onoclea) 857
Tree (Cibotium) 857
Walking (Camptosorus) 857
Wood, Shield (Dryopteris) 857
Woodwardia, Chain (Woodwardia) 858
Fescue
Netblotch 330, 332
Smut 591
Feverfew (Chrysanthemum parthenium) 858
Field Dodder 274
Fig
(Ficus carica) 858
Cyst Nematode 397
Florida Strangler (Ficus aurea) 859
Mosaic 631, 859
Pin Nematode 404
Rust 537
Smut 461
Spine Nematode 390
Figwort
Mosaic 860
Mosaic Caulimovirus 632
Figwort (Scrophularia) 860
Fijivirus 72
Filaree
Red Leaf 860, 900
Filbert 860
Blight 124, 128
Filipin 20
Fir
(Abies) 860
Needle Blight 182
Fir-Fern Rust 551, 552, 568, 569
Fir-Huckleberry Rust 566
Fir-Willow Rust 553
Fire 322, 323
Fire Blight 104, 165
Firecracker Plant (Crossandra infundibuliformis) 862
Firethorn 862
Fisheye Fruit Rot 470, 471
Fistulina hepatica 981
Fittonia 862
Flag Smut 588
Flat Limb 1006
Flax
Flowering (Linum) 862
Floral Smut 588
Florida Beggarweed (Desmonium tortuosum) 863
Florida Pusley (Richardia scaba) 863
Flower Blight 195
Flower Rot 457
Flower Smut 585
Flower Spot 293
Fluazinam 20
Fludioxonil 20
Flusilazole 21
Flutolanil 21
Fly Speck 286, 287
Foam-Flower (Tiarella) 863
Fobrella tsugae 174
Foliar Blight 179, 208, 484
Foliar Nematode 404
Folpet 21
Fomes 477
annosus 477, 726, 790, 861, 925, 952, 971, 1021, 1049, 1068, 1084
applanatus 477, 773, 954, 1027
arctostaphyli 952
conchatus 979, 1131
connatus 477, 874, 954, 1118
earlei 925
everhartii 477, 962, 1131
extensus 739, 947
fasciatus 949
fomentarius 477, 721, 792
fraxinophilus 478, 731, 764
fulvus 799, 1027
geotropus 739, 949
hartigii 1142
igniarius 478, 710, 721, 760, 764, 797, 837, 843, 952, 954, 1006, 1031, 1037, 1064, 1131
juniperinus 925

meliae 795
officinalis 478
pini 478, 786, 790, 825, 916, 1031, 1084
pinicola 478, 710, 721, 790, 916, 1006, 1084
ribis 823, 1064, 1075, 1140
rimosus 478, 942
robustus 478, 769
roseus 478, 726, 1084, 1142
scutellatus 710, 1139
subroseus 790, 948, 1084
texanus 925
Fomes spp. 748, 752, 772, 794, 838, 845, 892, 895, 898, 903, 907, 909, 930, 939, 942, 981, 1002, 1014, 1021, 1025, 1031, 1100, 1137
Fomes subroseus 925
Fomitopsis
officinalis 478
pinicola 478
rosea 478
Foot Rot 108, 137, 331, 332, 460, 509, 510, 513
Forestiera (Swamp-Privet) 863
Forget-Me-Not
Downy Mildew 278
Forget-Me-Not (Myosotis) 863
Forsythia (Goldenbells) 864
Fosetyl-Aluminum 21
Fouquieria (Ocotillo, Candlewood) 864
Four-O'Clock (Mirabilis) 864
Foxglove
(Digitalis) 864
Anthracnose 87
Leaf Spot 355
Foxtail
Mosaic 761
Mosaic Potexvirus 632
Frammulina (Collybia) 469
Frammulina velutipes 469
Freesia 865
Freeway Daisy (Osteospermum) 865
Freezing 760
Fremontia (Flannel Bush) 865
Frenching 1118
Fringe-Tree (Chionanthus) 866
Fritillaria 866
Froelichia 866
Frog-Eye Disease 313
Frog-Eye Leaf Spot 508, 509
Frommeella 545
duchesneae 545, 966
Frost Crack 954
Frost Injury 422
Frost Scorch 593
Frostwort (Crocanthemum) 866
Fruit
Anthracnose 89, 93
Blotch 115
Pit 984
Rot 91, 166, 173, 186, 232, 245, 255, 328, 346, 347, 353, 456, 461–464, 468–470, 474–476, 480, 486, 493, 497, 502, 503, 506, 514, 520, 531
Rot of date 464
Rots 519
Russet 286, 288
Spot 90, 93, 167–169, 177, 178, 221, 318, 319
Storage Rot 532
Fruit and Core Rot 506
Fuchsia 866
Rust 566
Fuligo
septica 581, 846, 888, 1094
violacea 1102
Fulvia fulva 373
Fumago 595
salicina 906
vagans 595, 722, 859, 904, 908, 940, 1002, 1023
Fumigants 11
Fungi 1164
Fungicide 11
Furcaspora 178
pinicola 178, 860
Furovirus 72

Fusaria 760
Fusarium 179, 244, 290, 299, 377, 480, 573, 687, 1007
acuminatum 480, 1087
annuum 687, 1012
avenaceum 480, 768, 838, 852, 861, 898, 908, 1021, 1084, 1087, 1091
Brown Rot 482
bulbigenum 713
buxicola 760
carpineum 902
ceralis 780
cerealis 483
circinatum 861, 1020
conglutinans var. 750
culmorum 480, 888, 914, 1069
decemcellulare 290, 951
equiseti 480, 960, 1087
foetens 687, 750
graminearum 179, 750, 1035, 1079, 1087, 1136
Head Blight 485
heterosporum 573, 887, 888
lateritium 377, 760, 795, 968, 1001, 1077, 1113
lateritium f. sp. cicerii 795
lateritium f. sp. pini 1020
moniliforme 480, 813, 859, 914, 987, 988, 1063
moniliforme var. intermedium 1020
moniliforme var. subglutinans 179, 244, 1019, 1020
nivale 592, 888
orthoceras 750
oxysporum 244, 481, 687–689, 691, 712, 721, 745, 760, 769, 799, 801, 819, 827, 836, 838, 840, 861, 865, 876, 898, 912, 918, 981, 986, 995, 1003, 1021, 1036, 1040, 1059, 1084, 1085, 1092, 1096, 1112
oxysporum f. sp. apii 687, 788, 1098
oxysporum f. sp. asparagi 688, 732
oxysporum f. sp. aurantiacum 849, 1128
oxysporum f. sp. barbati 688, 1103
oxysporum f. sp. basilicum 742
oxysporum f. sp. batatas 481, 922, 969, 1102
oxysporum f. sp. betae 688, 749
oxysporum f. sp. callistephi 688, 734, 789, 801, 956
oxysporum f. sp. carthami 1058
oxysporum f. sp. cassiae 784
oxysporum f. sp. cattleyae 688, 988
oxysporum f. sp. cepae 481, 985
oxysporum f. sp. chrysanthemi 481
oxysporum f. sp. conglutinans 688, 768, 1043, 1066, 1120
oxysporum f. sp. coriandrii 813
oxysporum f. sp. cubense 689, 740
oxysporum f. sp. cucumerinum 689, 822
oxysporum f. sp. cucurbitae 822
oxysporum f. sp. cyclaminis 689, 824
oxysporum f. sp. delphinii 829
oxysporum f. sp. dianthi 689, 781
oxysporum f. sp. erythroxyli 689, 849
oxysporum f. sp. exaii 852
oxysporum f. sp. gladioli 482, 920, 1109, 1115
oxysporum f. sp. hebae 689, 896
oxysporum f. sp. lactucum 689, 935
oxysporum f. sp. lilii 482, 938
oxysporum f. sp. lycopersici 689, 1113
oxysporum f. sp. mathioli 1091
oxysporum f. sp. medicaginis 1000
oxysporum f. sp. melonis 690, 961
oxysporum f. sp. narcissi 482, 974
oxysporum f. sp. niveum 690, 1087, 1134
oxysporum f. sp. perniciosum 690, 963
oxysporum f. sp. pisi 1000
oxysporum f. sp. radicis 1112
oxysporum f. sp. radicis-lycopersici 483, 1112
oxysporum f. sp. raphani 691, 1043

oxysporum f. sp. rhois 1096
oxysporum f. sp. sedi 1066
oxysporum f. sp. spinaciae 691, 1082
oxysporum f. sp. tracheiphilum 691, 801, 816, 1080
oxysporum f. sp. vasinfectum 745, 983, 1101
oxysporum var. redolens 483, 1021
Patch 592
poae 483, 833
proliferatum 483, 732, 807, 912, 986, 1085
Root Rot 483
roseum 483, 820, 827, 1069
roseum acuminatum 911
roseum f. sp. 885
roseum f. sp. sambucinum 838
sambucinum 908, 1035
sarcochroum 942
scirpi 761, 851, 875, 1079, 1133
semitectum 483, 960
solani 179, 244, 483, 691, 707, 710, 721, 726, 746, 760, 762, 769, 771, 795, 800, 804, 825, 827, 833, 838, 843, 861, 865, 870, 898, 912, 980, 981, 986, 1003, 1012, 1021, 1029, 1031, 1035, 1065, 1069, 1080, 1082, 1084, 1085, 1101, 1102, 1117, 1118, 1130, 1140
solani f. sp. cucurbitae 483, 1087
solani f. sp. glycines 1079
solani f. sp. phaseoli 484, 745, 746
solani f. sp. pisi 484, 795, 999, 1101
solani f. sp. radicicola 821
subglutinans 179, 244, 796, 986, 1012, 1019
subgutinans 484
tabacinum 179, 1086
tricinctum f. sp. poae 780, 800, 885
Wilt 481, 687–689, 691
Yellows 688, 1096
Fusarium sp. 299, 484, 732, 733, 735, 737, 755, 757, 763, 768, 776, 778, 779, 786, 800, 802, 805, 814, 815, 819, 824, 828, 834, 842, 851, 865, 871, 878, 880, 902, 913, 927–929, 934, 942, 945, 956, 964, 965, 969, 973, 995, 1010, 1015, 1029, 1030, 1055, 1061, 1063, 1067, 1074, 1095, 1103, 1116, 1123, 1125, 1144
Fusarium spp. 719, 749, 756, 782, 804, 813, 821, 829, 844, 865, 888, 953, 960, 991, 1001, 1004, 1012, 1035, 1036, 1053, 1087, 1094, 1102, 1145
Fusicladium 326
angelicae 717, 900, 1103, 1105
aplectri 988
cerasi 793
dendriticum 573
eriobotryae 573, 944
levieri 1014
photinicola 573
pisicola 326, 999
pyracanthae 573, 1040
robiniae 326, 942
saliciperdum 573, 1138
staticis 1090
Fusicoccum 244, 1024
amygdali 244, 1001
elaeagni 244, 842, 1058
putrefaciens 756
Fusicoccum sp. 731, 948, 970

Gaeumannomyces 484
graminis 789
graminis var. graminis 484, 888, 1009, 1060, 1066, 1145
Gaillardia (Blanket Flower) 867
Galax 867
Galium (Bedstraw) 867
Gall 264, 290, 293
Gall Rust 551
Gallex 26
Galtonia (Summer-Hyacinth) 868
Ganoderma 484
applanatum 485, 704, 710, 721, 739, 748, 817, 850, 910, 972, 1117, 1118

applanatus 1039
curtisii 485, 845, 903, 907, 1002
lucidum 485, 514, 731, 760, 805, 892, 898, 907, 954, 963, 1047, 1132, 1137
oregonenses 797
oregonensis 838
polychromum 773
sequoiae 1068
sulcatum 932, 992
zonatum 485
Ganoderma sp. 755
Ganoderma spp. 1100
Gardenia
Canker 256
Gardenia (Cape-Jasmine) 868
Garlic
(Allium sativum) 869
Garrya (Tassel-Tree, Silk-Tassel Bush) 869
Gas Toxicity 423
Gasteromycetous fungus 796
Gaultheria (Checkerberry, Teaberry) (Source of Oil of Wintergreen) 869
Gaura 869
Gazania 870
Gazania (Treasure flower) 870
Geastrumia 219
polystigmatis 219, 719
Geastrumia polystigmatis 753
Gelatirosporium piricola 236
Genista (Wood-waxen) 870
Gentian (Gentiana) 870
Geoglossaceae 56
Geotrichum
candidum 500, 976, 1002, 1102
citriaurantii 500
Geranium
(Cranesbill, Herb-Robert) 872
(Pelargonium) 870
(Pelargonium) Mosaic 632
Chlorotic Spot 632
Crinkle 632
Leaf Spot 127, 129, 311
Mosaic 871
Gerbera (Transvaal Daisy) 872
Germander (Teucrium) 873
Geum (Avens) 873
Ghost Ring 1065
Giant Hill 1034
Gibbago 327
Gibbago trianthemae 327, 910
Gibberella 179, 244, 485
acuminatum 910
baccata 179, 244, 708, 719, 803, 815, 858, 878, 909
baccata var. mori 972
persicaria 1001
quinqueseptata 899
saubinetti 899
zeae 485, 813, 888, 1112
Gibberidea
abundans 1039
heliopsidis 136, 734, 879, 897, 1060, 1097
Gilbertella 486
Gilbertella persicaria 486, 1001
Gilia (Skyrocket) 873
Gillenia (American Ipecac, Indian Physic) 874
Ginger, Edible (Zingiber) 874
Ginger, Wild (Asarum) 874
Ginkgo (Maidenhair-Tree) 874
Ginseng
(Panax) 874
Girdle 749
Girdling Roots 424
Gladiolus 875
Botrytis Blight 160
Flower Blight 170
Mosaic 633
Scab 113
Smut 588
Glassy End 1034
Gleosporium sp. 895
Gliocephabotrichum
bulbilium 1044
simplex 1044

Gliocladium
(Isaria) 491
roseum 491, 502
vermoeseni 502, 991
viride 721
Gliocladium sp. 1035
Globe-Amaranth (Gomphrena) 876
Globe-Mallow (Sphaeralcea) 876
Globe-Thistle (Echinops) 877
Globodera
rostochiensis 396, 841, 1034
tabacum solanacearum 978
Gloecephalus hemerocalli 828
Gloeocercospora 327
inconspicua 327
sorghi 327
Gloeocereocospora inconspicua 756
Gloeodes 220
pomigena 220, 719, 753, 803, 816, 832, 869, 987, 1004, 1138
Gloeophyllum sepiarium 492, 930
Gloeosporium 90, 245, 327, 486
acerinum 953
aceris 953
affine 987
ailanthi 708
aletridis 1089
aleuriticum 1118
allantosporum 90, 1045
amygdalinum 711
angelicae 717
apocryptum 90, 759, 953
aquifolli 904
argemonis 1037
aridum 90, 730
berberidis 741, 949
betae 748
betularum 327
cactorum 769
callae 774
camphorae 777
carthami 1058
catalpae 785
cattleyae 987
confluens 728
convallariae 938
coryli 896
crataegi 894
diospyri 1013
fagi 748
ferrugineum 1049
foliicolum 486, 804
frigidum 850
fructigenum 842, 890, 998
hemerocallidis 1081
heterophyllum 728
hydrophylli 914
inconspicuum 327, 844
leguminum 962
limetticolum 90, 803
liriodendri 1117
manihotis 952
melongenae 90, 841
mezerei 327, 828
minus 818
musarum 740
nervisequum 1099
ochraceum 777
oleae 1100
olivarum 984
osmaroniae 989
osmundae 856
paludosum 728
perennans 714
piperatum 90, 1011
polymorphum 839
prunicola 799
quercinum 90, 979
ramosum 963
revolutum 942
rhododendri 327
robergei 908
rumicis 1057
saccharinum 953
salicis 1137
sanguinariae 755
sansevieriae 1063
senecionis 1067

septorioides 980
syringae 936
tabernaemontanae 1105
thalictri 958
thuemenii 771, 839
thuemenii f. sp. tulipi 90, 1116
tineum 843
trillii 1115
tubiformis 709
ulmicola 328, 844
veronicae 1125
yuccogenum 1142
Gloeosporium sp. 90, 245, 705, 716, 735, 738, 750, 751, 756, 762, 770, 796, 799, 814, 818, 820, 821, 833, 839, 840, 864, 872, 904, 923, 967, 975, 983, 990, 1006, 1009, 1010, 1016, 1017, 1028, 1032, 1033, 1040, 1048, 1055, 1056, 1073, 1086, 1090, 1092, 1093, 1105
Gloeosporium spp. 721, 819, 1052, 1137
Gloeotinia 486
granigera 486
temulenta 486, 888
Gloesporium
betulae-luteae 752
Gloesporium betularum 752
Gloesporium cactorum 770
Gloesporium sp. 813
Glomerella 91, 179, 245, 328, 486
cincta 771, 833, 839, 906, 955, 992
cingulata 91–93, 179, 199, 245, 258, 328, 486, 720, 721, 728, 736, 751, 753, 754, 756, 757, 775, 777, 789, 791, 802, 803, 805, 806, 823, 824, 832, 841, 874, 884, 891, 893, 908, 909, 918, 920, 948, 951, 958, 970, 974, 992, 995, 1001, 1005, 1007, 1011, 1030, 1038, 1041, 1045, 1048, 1051, 1052, 1056, 1074–1076, 1100, 1112, 1118
cingulata var. vaccinii 487, 818
glycines 93, 1078
gossypii 93
lindemuthianum 94
nephrolepidis 94, 854
phomoides 1109
rubicola 721, 1045
Glomerella sp. 328, 987
Glomerularia corni 835
Glomus macrocarpum 978
Glory-Bush (Tibouchina) 877
Gloxinia (Sinningia) 877
Glutinium
macrosporum 245, 719
microsporum 1005
Gnaphalium (Cudweed) 877
Gnomonia 94, 179, 328
caryae 94, 902
caryae var. pecanae 328, 1007
comari 328, 1093
fragariae 328
fructicola 1093
leptostyla 95, 1130
nerviseda 328, 1007
platani 1025
quercina 979
rubi 179, 753, 754
tiliae 939
ulmea 328, 844
Gnomoniaceae 55
Gnomoniella 329
coryli 329, 896
fmbriata 329
fraxini 90
Goats-Beard (Aruncus) 878
Godetia 878
Godfrey's Meadow Nematode 405
Godronia 487
cassandrae f. sp. vaccinii 487, 756
Godronia cassandrae 487, 756, 818
Going-Out 331, 332
Golden Nematode 396, 397
Golden-Chain (Laburnum) 878
Golden-Club (Orontium) 878
Golden-Eye (Viguiera) 878
Golden-Glow (Rudbeckia lacinata) 879

Golden-Larch (Pseudolarix) 879
Goldenrain-Tree (Koelreuteria) 879
Goldenrod
  Scab 599
Goldenrod (Solidago) 879
Goldenseal (Hydrastis) 880
Goldentop (Lamarckia) 880
Goldthread (Coptis) 881
Golovinomyces
  cichoracearum 442, 705, 708, 727–729, 734, 735, 739, 750, 758, 771, 772, 776, 779, 788, 800–802, 812, 815, 820–822, 825, 826, 829, 837, 840, 841, 846, 848, 850, 851, 858, 867, 872, 873, 878–880, 882, 889, 894, 897, 901, 905, 908, 914, 917, 919, 920, 929, 932, 934, 936, 939, 941, 955, 957, 960–962, 964–966, 973, 976, 983, 995, 1009, 1017, 1030, 1031, 1035, 1037, 1039, 1042, 1047, 1056, 1058–1061, 1067, 1071, 1087, 1091, 1092, 1097, 1106–1108, 1115, 1120, 1121, 1123, 1124, 1133, 1139, 1141, 1144
  cynoglossi 863
  orontii 1122
Gonatobotryum 329
  apiculatum 329
  maculicola 1139
Gooseberry
  (Ribes) 881
  Scab 601
Gopher Plant or Caper Spurge (Euphorbia) 881
Gordonia (Franklinia and Loblolly-Bay) 882
Gouania 882
Gourd (Lagenaria, Luffa, Trichosanthes) 882
Grading Injuries 424
Graft Incompatibility 424
Graft Union Necrosis 722
Grandinia (Hyphodontia) 490
Grandinia granulosa 490
Granville Wilt 115, 121
Grape
  Anthracnose 596
  Downy Mildew 281
  Fanleaf 884
  Leaf Roll 884
  Leaf Roll = Grapevine Leafroll-Associated Closterovirus 633
  Powdery Mildew 452
  Yellow Mosaic 884
  Yellow Mosaic F Strain of Grapevine Fanleaf Nepovirus (Panachure) 633
  Yellow Vein = Tomato Ringspot Nepovirus 634
Grape (Vitis) 882
Grape-Hyacinth (Muscari) 885
Grapefruit 884
Grapevine
  Fanleaf Nepovirus 633
  Fleck 884
  Fleck Virus 633
  Rupestris Vein Feathering 884
  Rupestris Vein Feathering Marafivirus 633
  Stem Pitting Associated 884
  Stem Pitting Associated Chlosterovirus 633
Graphiola 584
  congesta 994
  phoenicis 584, 992, 993
  thaxteri 994
Graphiola phoenicis 994
Graphiolaceae 60
Graphium 329
  hamamelidis 1139
  sessile 765, 1063
  sorbi 330, 970
  ulmi 683
Graphium spp. 1021
Grapvine Fanleaf 889
Grass
  Cyst Nematode 397

Nematode 385
Sneath Nematode 395
Grass-Of-Parnassus (Parnassia) 889
Grasses, Lawn, Turf 885
Gray
Bark 174
Blight 377
Leaf 345, 346
Leaf Blight 182, 378
Leaf Mold 331, 332
Leaf Spot 364
Mold 160
Mold Blight 156
Mold Fruit Rot 463
Mold Neck Rot 462
Mold Rot 156, 462
Scab 600
Spot 350
Gray Bulb Rot 522
Greasy Blotch 222
Greasy Spot 804
Green Dwarf 1036
Green Fruit Rot 525
Green Mold 503
Green Mold Rot, Cosmopolitan 531
Green Mottle 722
Green Ring Mottle 1002
Green Scurf 308
Greeneria 485
uvicola 485, 494, 884
Gremmeniella abietina 1019
Grevillea (Silk-Oak) 889
Grindelia (Gumweed) 889
Griphosphaeria 246
corticola 246, 1052
Ground-Cherry, Husk-Tomato (Physalis) 890
Ground-Cherry, Purple-Flowered (Quincula) 890
Ground-Ivy (Gleoma) 890
Ground-Smoke (Gayophytum) 891
Groundnut (Apios) 891
Grovesiella abieticola 262
Grovesinia pyramidalis 1130
Growth Cracks 1034
Guar
Symptomless 891
Symptomless Potyvirus 634
Guar (Cyamopsis) 891
Guava
Scab 601
Guava (Psidium) 891
Guayule (Parthenium) 891
Guignardia 220, 330, 487
aesculi 220, 909
bidwellii 488, 715, 884, 920, color plate 7
bidwellii f. sp. parthenocissi 330, 1013, 1128
leucothoës 935
lonicerae 907
rhodorae 1049
vaccinii 488, 818
Gum Spot 1027
Gummosis 226, 424, 475, 510, 704, 723, 804, 1001
Gummy Stem Blight 186, 187
Gymnoascaceae 53
Gymnoconia
interstitialis 546
nitens 552
peckiana 546, 754, 832, 1046
Gymnosporangium 546
asiaticum 549
bermudianum 547, 925
bethelii 547, 895, 925
biseptatum 547, 714, 790
clavariiforme 547, 714, 798, 925, 1006, 1041
clavipes 547, 714, 722, 798, 817, 895, 925, 926, 959, 1006, 1018, 1041, 1042
confusum 548
corniculans 714, 925
cornutum 548, 925, 970
cunninghamianum 548
cupressi 714, 825
davisii 548, 798, 925

effusum 548, 925
ellisii 548, 743, 790, 1098, 1099, 1135
exiguum 548, 895, 925
exterum 548, 874, 925, 926
floriforme 548, 895, 925
fraternum 548, 790, 798
fuseum 1006
globosum 548, 722, 817, 895, 925, 926, 970, 1006
gracile 549, 714, 925, 1041
harknessianum 549, 714, 925
hyalinum 549, 895, 1006
inconspicum 925
inconspicuum 549, 714, 1088
japonicum 549, 926, 1018
juniperi-virginianae 549, 722, 817, 925, color plate 2
juvenescens 714, 926
kernianum 550, 714, 926, 1006
libocedri 550, 714, 722, 817, 895, 916, 1041, 1042
multiporum 550, 926
nelsoni 714, 817, 895, 926, 970, 1041, 1088
nelsonii 551
nidus-avis 551
nidusavis 714, 722, 926, 1041
nootkatense 551, 790, 817, 970, 1006
speciosum 551, 853, 926, 966
trachysorum 551, 895, 926
tremelloides 551, 926, 970
tubulatum 895, 926
vauqueliniae 551, 926
Gymnosporium
exiguum 799
Gypsophila (Babys-Breath) 892

Hackberry
Leaf Mosaic 892
Sugarberry (Celtis) 892
Hadrotrichum 180
globiferum 180, 945
Hairy Mistletoe 369
Hairy Root 98
Halbaniella linnaeae 940
Halesia (Silver-Bell, Snowdrop-Tree) 893
Halo Blight 116
Hamelia (Scarlet-Bush) 893
Hand-Operated Sprayers 33
Hapalosphaeria deformans 753, 832
Haplobasidium pavoninum 810
Harbinger-Of-Spring (Erigenia) 893
Hard
End 1005
Hardenbergia 893
Hardy Orange (Poncirus) 893
Hares-Tail (Lagurus) 893
Harknessia rhoina 1096
Hawkbit, Fall Dandelion (Leontodon) 893
Hawksbeard (Crepis) 894
Hawkweed (Hieracium) 894
Hawthorn
(Crataegus) 894
Leaf Blight 178
Hawthorn Rust 548
Hazel
Dodder 274
Hazelnut
Filbert (Corylus) 895
Leaf Blister 296
Head Blight 179
Head Browning 303
Head Rot 513, 523
Head Scab 573
Head Smut 586, 589
Heart Rot 298, 425, 469, 473, 477, 478, 480, 485, 492, 504, 997, 1104
Heartwood
Rot 476
Heat Injury 425
Heath (Erica) 896
Heather (Calluna) 896
Hebe 896
Hedge
Parsley (Torilis) 897

Helenium (Sneezeweed) 897
Helenium S. 897
Helichrysum 897
Helicobasidium 488
brebissonii 489
corticioides 489
purpureum 715, 731, 749, 760, 765, 782, 785, 795, 812, 832, 843, 845, 878, 892, 903, 917, 951, 954, 972, 1008, 1035, 1047, 1056, 1072, 1075, 1076, 1097, 1102, 1124, 1128, 1129, 1137
Helicoceras nymphaearum 1132
Helicotylenchus 394
dihystera 394, 887
erythrinae 394, 1012, 1079
multicinctus 394, 1020
nannus 394, 733, 738, 760, 771, 775, 868, 887, 993, 1003, 1016, 1056, 1079, 1111
pseudorobustus 394, 883
Helicotylenchus sp. 756, 1066
Helicotylenchus spp. 1053
Heliopsis 897
Heliotrope (Heliotropium) 897
Hellenium S. Carlavirus 634
Helminthosporium 180, 286, 330, 489, 906
(Spondylocladium) 579
allii 985
apiculiferum 994
beaumontii 1125
cactivorum 489, 769
catenarium 180, 332, 1050
cynodontis 332, 887
dictyoides 332, 887
erythrospilum 332, 887
gigantea 180
giganteum 332, 887, 1009, 1050
hawaiiense 1048
maydis 180, 813
molle 991
papulosum 287, 719, 1005
pedicellatrum 813
rostratum 332, 762, 887
sacchari 933
sarracenia 1024
sativum 332, 887, 1104
sesami 489, 1068
setariae 332
siccans 332, 887
solani 579
sorokiniana 332
stenacrum 332, 887
stenophilum 887
tetramera 1145
triseptatum 332, 887
tritici-repentis 332
turcicum 180, 489, 813
vagans 332, 887
vignae 1078
Helminthosporium (Bipolaris) portulacae 1033
Helminthosporium sp. 736, 740, 956, 977, 993, 994, 1004, 1028, 1110, 1116, 1133
Helotiaceae 57
Helvellaceae 57
Hemicriconemoides 395
biformis 395
chitwoodi 395
floridensis 395
gaddi 395, 775
wessoni 395, 1135
Hemicriconemoides biformis 981
Hemicycliophora 395
arenaria 395
brevis 395, 772
obtusa 395, 749
oracilis 875
parvana 395, 787, 839
similis 395, 756, 817
Hemicycliophora sp. 954, 1046
Hemicycliophora spp. 1053
Hemlock
Blight 174
Dwarf Mistletoe 371
Needle 174

Needle Blight 174, 177, 178, 208
Rust 567
Hemlock (Tsuga) 898
Hemlock-Poplar Rust 553
Hemp
(Cannabis) 899
Hemp Broomrape 223
Hempsesbania (Sesbania) 899
Henbane Mosaic 634
Henbit (Laminum) 899
Hendersonia 300, 333
concentrica 333, 1049
crataegicola 333, 894
culmiseda 994
cydoniae 1005
davisii 902
foliorum var. viburni 1125
magnoliae 948
opuntiae 300, 769, 770
rubi 711
subalbicans 775
tenella 1063
tini 931, 1125
Hendersonula 246, 691
pinicola 1019
toruloidea 246, 692, 803, 948, 1130
toruloides 859
Hepatica 899
Heracleum (Cow-Parsnip) 900
Hercules-Club (Aralia spinosa) 900
Hercules-Club (Zanthoxylum clava-herculis) 900
Hericium 489
erinaceous 954, 981
erinaceus 490, 1014, 1100, 1118
obietis 528
Hericium spp. 748
Heronsbill (Erodium) 900
Herpobasidium
deformans 907
filicinum 857
Herpotrichia 181
juniperi 181, 965
nigra 837, 860, 898, 916, 924, 970, 1019, 1083, 1142
Hesperis (Dames-Rocket) 900
Heterobasidion annosum 478
Heterodera
avenae 396, 999
cacti 396, 769
carotae 396, 782
cruciferae 396, 767
fici 397, 859
glycines 397, 744, 1079, 1111
gottingiana 397, 999, 1079
humuli 397, 744, 821, 999
iri 397, 887
mothi 397, 979
punctata 397, 883
rostochiensis 397, 841, 1034, 1111
schachtii 397, 748, 973, 975, 1061
tabacum 397, 841, 923, 1012, 1111
trifolii 398, 748, 780, 1079, 1082
zeae 398, 813
Heterodera and Globodera 395
Heterosporium 181
abroniae 1062
allii 334, 985
asperatum 1077
echinulatum 334, 780, 833
escholtziae 334
eschscholtziae 773
gracile 334, 798
gracilis 828
hybridum 806
iridis 865, 994
magnoliae 948
syringae 181, 936
trillii 1115
tropaeoli 975
variabile 334, 767, 1082
Heterosporium sp. 726, 835, 875, 937, 946, 1059, 1115, 1127, 1129
Heuchera (Alum-Root, Coral-Bells) 901
Hexaconazole 21
Hibbertia (Guinea-Gold-Vine) 901

Hibiscus
(Arborescent Forms) (Rose-of-Sharon, Confederate-Rose, Chinese Hibiscus, Kenaf) 901
Chlorotic Ringspot 902
Chlorotic Ringspot Carmovirus 634
Latent Fort Pierce 902
Latent Fort Pierce Tobamovirus 634
Hickory
Anthracnose 94
Hickory (Carya) 902
Higginisia 182
hiemalis 182, 318
kerriae 182, 318
Hippeastrum 903
Mosaic 713
Mosaic Potyvirus 634
Hoarhound (Marrubium) 903
Hoary-Tick Clover (Desmodium) 903
Hollow Heart 425, 1034
Hollow Pocket 515, 517
Hollow Stem 787
Holly
(Ilex) (Ilex opaca, American; I. equifolium, English; I. cornuta, Chinese; I. crenata, Japanese) 903
Blight 201
Leaf Spot 349, 350
Osmanthus (Osmanthus ilicifolius) 905
West Indian (Leea coccinea) 906
Hollyhock
(Althaea) 905
Anthracnose 88
Mosaic 634, 905
Rust 564
Holodiscus
Witches' Broom 635, 906
Holodiscus (Ocean Spray, Rock-Spirea) 906
Homalomena 906
Honesty (Lunaria) 906
Honey
Locust (Gleditsia) 906
Honey Plant, Bitterbush (Picramnia) 907
Honeysuckle
(Lonicera) 907
Hop
American Latent 908
American Latent Carlavirus, Hop Latent Carlavirus, Hop Mosaic Carlavirus 635
Cyst Nematode 397
Latent 908
Mildew 451
Mosaic 908
Stunt Viroid 976, 1002
Hop (Humulus) 908
Hop-Hornbeam, Ironwood (Ostrya) 908
Hop-Tree (Ptelea) 909
Hoplolaimus 398
bradys 839
coronatus 398, 780, 803, 887, 977, 981, 1020, 1101, 1111
galeatus 398
magnistylus 398, 902
uniformis 398, 836, 904, 949
Hoplolaimus sp. 946, 1053
Hopperburn 425, 1034
Hordeivirus 72
Hormodendron cladosporiodes 721
Hormotheca rubicola 364
Hornbeam (Carpinus) 909
Horse
Purslane (Trianthema) 910
Horse-Chestnut Leaf Blotch 220
Horse-Chestnut Powdery Mildew 452, 453
Horse-Chestnut, Buckeye (Aesculus) 909
Horse-Gentian (Triosteum) 910
Horse-Radish (Armoracia) 911
Horse-Radish Leaf Spot 122, 311
Horseweed (Conyza) 911
Hosta (Plantain-Lily) 911

Hosta Virus X 912
Houstonia (Bluets) 912
Hoya 912
Huckleberry
  Evergreen (Vaccinium) 912
Huckleberry (Gaylussacia) 912
Huisache, Sweet Acacia (Acacia farnesiana) 913
Hyacinth
  Botrytis Blight 160
  Mosaic 913
  Mosaic Potyvirus 635
  Yellows 125
Hyacinth (Hyacinthus) 913
Hyacinth Yellows 129
Hyalodendron sp. 980
Hyalopsora 551
  aspidiotus 551, 858, 861
  cheilanthis 552, 855, 857
  polypodii 552, 854, 858
Hybrigeminivirus 72
Hydnaceae 61
Hydnum
  abietis 861
  balsameum 861
  coralloides 838
  septentrionale 528
Hydrangea 913
  Latent 914
  Latent Carlavirus 635
  Leaf Spot 350
  Phyllody Phytoplasma 635
  Ring Spot 914
  Ring Spot Potexvirus 635
  virescence 913
Hydrated Lime and Copper Sulfate 21
Hydraulic Sprayers 31
Hydrilla 914
Hydrophyllum (Waterleaf) 914
Hydrophyllum Leaf Spot 358
Hydroxyquinoline Sulfate 21, 27
Hymatotrichum omnivorum 721
Hymenochaete 246
  agglutinans 246, 709, 719, 751, 843, 895, 898, 936, 953, 965, 972, 1064, 1099, 1125
  Canker 246
  tabacina 1068
Hymenopappus 915
Hyphodontia aspera 1084
Hypholoma 490
  perplexum 823
  sublateritium 490
Hypoderma 182, 377
  desmazierii 377, 1020
  hedgecockii 377, 1020
  lethale 182, 1020
  lethali 377
  pedatum 1020
  pini 1020
  robustum 377, 378, 861
  saccatum 1020
Hypodermella 182, 378
  abietis-concoloris 182, 378, 861
  ampla 378, 1020
  arcuata 1020
  cerina 1020
  concolor 378, 1020
  lacrimformis 1020
  laricis 182, 378, 930
  limitata 1020
  medusa 1020
  mirabilis 861
  montana 1020
  montivaga 1020
  nervata 378, 861
  punctata 861
Hypodermella sp. 1020
Hypomyces
  cancri 899
  ipomoeae 183, 1088
Hyponectria 183
  buxi 183, 760
Hypospila californica 709
Hypoxylon 248
  atropunctatum 980, 981

Canker 248
diatrypeoides 962
mammatum 248
mediterraneum 980
morsei 953
pruinatum 1031
punctulatum 980
tinctor 1025
Hypoxylon spp. 719, 1064
Hypsizygus ulmarius 514
Hypsoperine 398
graminis 398, 887, 1145
Hyssop (Hyssopus) 915
Hysteriaceae 54

Ice
Plant (Carpobrotus) 915
Idaeovirus 72
Idriella 490
lunata 490, 1094
Ilarvirus 72
Illosporium 334
maculicola 954
malifoliorum 334, 719, 817
Imazalil 21
Impatiens
Latent 915
Latent Potexvirus 636
Necrotic Spot 750, 801, 802, 824, 845, 852, 877, 912, 915, 986, 1004, 1012, 1036, 1038, 1045, 1064, 1074
Necrotic Spot Phytoplasma 979
Necrotic Spot Tospovirus 636
Serotype 706, 969, 1015
Impatiens (Garden Balsam, Sultan) 915
Incense Cedar Mistletoe 369
Incense-Cedar (Libocedrus [= Calocedrus decurrens]) 916
India-Hawthorn (Raphiolepis) 916
Indian Cucumber-Root (Medeola) 916
Indian Grass (Sorghastrum) 916
Indigo (Indigofera) 916
Indigo-Bush, Lead-Plant (Amorpha) 917
Inflorescence Smut 585
Ink Spot 187, 188, 315, 316, 875
Inkberry (Ilex glabra) 917
Inonotus 490
circinatus 517
dryadeus 515
hispidus 515
tomentosus 490, 515, 1084
Insecticide 11
Internal
Bark Necrosis 720, 1001
Breakdown 1102
Brown Spot 1034, 1102
Browning 723, 1133
Browning or Cork 425
Intumescence 999, 1102
Inula (Elecampane) 917
Ionomutus circinatus 1021
Ipomovirus 72
Iprodione 21
Irene
araliae 141, 948
calostroma 141, 1134
perseae 141, 736
(Irene) Asteridiella 141
Irenina
manca 141, 980, 1134
sanguinea 832
Irenopsis
cryptocarpa 142
martiniana 142, 1047
Iresine (Blood-Leaf) 917
Iris
Basal Rot 481
Fulva Mosaic 919
Fulva Mosaic Potyvirus and Iris Severe Mosaic Potyvirus 635
Mosaic 739, 819, 865, 918, 920, 1080, 1095, 1115, 1134
Mosaic = Iris Mild Mosaic Potyvirus 636
Rust 563

Severe Mosaic 918, 919
Yellow Bunyaviridae 1080
Yellow Spot Tospovirus 636
Iris (Bulbous) (English, Spanish, Dutch) 918
Iris (Rhizomatous) (German, Siberian, Native Species) 918
Irish
Leaf Spot 322, 323
Iron Deficiency 425
Ironweed
(Vernonia) 919
Irpex 491
lacteus 491
tulipiferae 719
Isaria
clonostachoides 491, 1112
Rot 491
Isariopsis 334
griseola 334, 744, 1100
laxa 744
Island Chlorosis 892
Issatchenkia scutulata 976, 1002
Isthmiella
abietis 376
faulii 376
Italian Dandelion (Cichorium intybus) 919
Itchgrass
(Rottobellia) 919
Itersonilia 183
perplexans 183, 733, 800, 834, 997, 1097
Itersonilia sp. 183
Ivesia 919
Ivy
Boston (Parthenocissus tricuspidata) 919
English (Hedera helix) 920
Ixia 920
Mosaic 636
Ixora 921
Jacaranda 921
Jack-Bean, Sword Bean (Canavalia) 921
Jack-In-The-Pulpit (Arisaema) 921
Jacobinia 921
Jacquemontia (Small Flower Morning Glory) 921
Jacquinia 922
Jamesia (Cliffbrush) 922
Jasmine (Jasminum) 922
Jasmine Scab 598
Jatropha 922
Java Black Rot 475
Javanese
Root-Knob Nematode 403
Jerusalem-Cherry
(Solanum pseudocapsicum) (Also Solanum capsicastrum, False Jerusalem- cherry; S. dulcamara, Bittersweet; S. integrifolium, Scarlet Eggplant; S. nigrum, Black nightshade) 923
Jetbead (Rhodotypos) 923
Jipijapa (Carludovia palmata) 923
Jobs-Tears (Coix lachryma-jobi) 923
Johnsongrass
Mosaic Potyvirus 636
Johnsongrass (Sorgum) 924
Johnsongrass Mosaic 924
Jointweed (Polygonello articulata) 924
Jojoba (Simmondsia) 924
Jonathan Spot 720
Jujube (Zizyphus) 924
Junghuhnia luteoalba 517
Juniper
Blight 197
Gall Rust 548
Mistletoe 369
Red-Cedar (Juniperus) 924

Kabatia 335
lonicerae 335, 907
periclymeni 336

Kabatiella
microsticta 918, 938
phorodendri f. sp. umbellulariae 772
zeae 813
Kabatiella sp. 828
Kabatina 248
juniperi 248
Kageneckia 926
Kalanchoe 926
Latent 927
Top-Spotting 927
Top-Spotting Badnavirus 637
Kalmia Leaf Spot 350
Kansas Lettuce Disease 114
Kaskaskia gleditsiae 906
Kellermania
anomala 184
sisyrinchii 184, 757
Kellermannia 184
anomala 1142
Kentucky Coffee-Tree (Gymnocladus) 927
Kernel Spot 498, 1008
Kerria 927
Leaf 182
Leaf Spot 317, 318
Kidney Vetch, Ladys-Fingers (Anthyllis) 927
Kiwi
(Actinidia) 927
Kloeckera apiculata 976, 1002
Kluyveromyces 491
marxianus var. marxianus 491, 986
Kniphofia (Tritoma, Torch-Lily, Poker-Plant) 927
Knobbiness 1034
Knotroot Bristlegrass (Setaria geniculata) 928
Kochia (Summer-Cypress) 928
Kohleria 928
Kresoxim-Methyl 21
Kriegeria sp. 925
Krigia (Dwarf Dandelion) 928
Kudzu (Pueraria) 928
Kuehneola 552
malvicola 552, 902, 951, 1055
uredinis 552, 754, 832, 1046
Kuhnia (False-Boneset) 929
Kumquat (Fortunella) 929
Kunkelia 552
nitens 552, 754, 832, 1046
Kutilakesa 292
pironii 292, 807, 820

Labrella 184
aspidistrae 184, 733
Laburnum
Mosaic 637
Labyrinthula sp. 885
Lachnellula 248
agassizi 238
pseudotsuga 238
resinaria 239
subtilissima 239
willkommii 239, 248, 930
Laestadia
asarifolia 353
brunnea 954
prenanthis 1037
Laestadia (Plagiostoma) 353
Laetiporus sulphureus 515, 516
Laetisaria fuciformis 471
Lambertella
pruni 724, 1027
Lambertella sp. 792
Lamium (Perennial Groundcover) 929
Lantana 929
Lappula (Hackelia) 929
Larch
(Larix) 930
Needle 182, 378
Larch Needle Rust 553
Larch-Willow Rust 554
Large Brown Patch Rot 500
Larkspur 931
Lasiobotrys 335
affinis 907

lonicerae 335
symphoricarpi 1075
Lasiobotrys lonicerae 907
Lasiodiplodia 491
Lasiodiplodia (Botryodiplodia) 461
Lasiodiplodia theobromae 175, 176, 226, 241, 461, 475, 491, 841, 1004
Lasmenia sp. 1044
Late
Blight 201
Blight of Potato 202
Blight of Tomato 204
Late Leaf Rust 566
Laurel 931
Laurel, Sweet Bay (Laurus) 931
Laurestinus (Viburnum tinus) 931
Lavatera (Treemallow) 931
Lavender (Lavandula) 931
Lawns 932
Layia (Tidy-Tips) 932
Le Moine Disease 1010
Leadtree (Leucaena) 932
Leaf 163
and Cane Rust 557
and Crown Necrosis 526
and Flower Spot 128
and Petal or Greasy Spot 330, 332
and Pod Spot 89, 92, 330, 332
and Stalk Blight 161
and Stalk Rot 475
and Stem Blight 200
and Stem Smut 587, 588
and Stem Spot 306, 313
and Twig Blight 175
Blight 90, 92, 111, 122, 153, 166, 167, 171, 180, 183–188, 192, 194–196, 201, 206, 209, 213, 215, 321, 337, 338, 353, 361, 489
Blister 295, 297
Blotch 84, 219, 221, 312, 313, 321, 328, 341, 358, 881, 904
Cast 183, 261
Crinkle 1143
Curl 297
Curl and Wilt 311, 314
Drop 512, 1017
Fleck 338
Gall 289, 293
gall 292
Hair Discoloration 344
Mold 331–334, 372–374
Mottle 748
Rust 565, 567
Rust of Rose 556
Scald 122, 910
Scorch 298–300, 427, 720, 748, 785, 875, 881, 954, 1008, 1053, 1131
Smut 583, 584, 588
Spot 84, 87, 94, 95, 102, 103, 109, 111, 113–115, 120, 124, 126, 128, 130, 152, 153, 170–172, 186, 199, 206, 250, 300, 303–308, 310–322, 324–357, 359–365, 571, 584, 960
Spot or Greasy Spot 341
Spot/Blotch 328
Streak 122
Yellow Strip Virus 869
Yellow Strip, Mosaic, Dwarfism 869
Yellows 923
Leaf, Stem and Bub Blight 206
Leaf, Stem and Fruit Spot 97
Leafroll 1111
Leafroll Disease 884
Leak 519
Leatherwood (Dirca) 932
Lebbek (Albizzia lebbek) 932
Lecanosticta sp. 1019
Ledum
Spot Anthracnose 598
Ledum (Labrador-Tea) 932
Leek 932
Lembosia
(Morenoella) 141
acicola 1019
andromedae 947
cactorum 142, 770
camphorae 777
coccolobae 142, 808

illiciicola 142, 717
lucens 869, 1070
oleae 831
philodendri 808
portoricense 808
rolfsii 1122
rugispora 142, 1047
tenella 808
Lembosina
(Morenoella) 340
quercina 340
Lemon 933
Lemon Grass, Citronella Grass (Cymbopogon) 933
Lenticel Enlargement 1034
Lentil (Lens) 933
Lentinus 491
lepideus 492, 1021
tigrinus 492, 731, 981, 1014
Lentinus spp. 1119
Lenzites 492
betulina 492, 748, 772, 836, 940
betulinum 845
saepiaria 492, 710, 726, 790, 825, 838, 916, 925, 930, 948, 1002, 1021, 1027, 1031, 1068
trabea 710
Lenzites spp. 739, 954
Leopard Spot Disease 600
Lepiota morgani 284, 886
Leprosis 804
Leptographium
(Verticicladiella) 532
abietinum 532
penicillata 532
procera 533
procerum 1021
terebrantis 1021
wagenerii 533
Leptospermum 933
Leptosphaeria 136, 138, 184, 249, 492
(Melanomma) conithyrium 185
berberidis 949
coniothyrium 249, 719, 753, 754, 832, 881, 1045, 1052, 1094
heliopsidis 136
korrae 185, 492, 885, 886
maculans 138, 767, 778
obtusipora 1143
physalidis 890
thomasiana 185, 832
tini 931, 1125
Leptosphaeria sp. 185, 833, 964
Leptosphaerulin arachidicola 1003
Leptostromataceae 63
Leptostromella 335
bignoniae 751
elastica 335, 1056
Leptothyrella 335
acerinum 954
californicum 980
pomi 869, 1041
Leptothyrella liquidambaris 336, 1099
Leptothyrium 336
californicum 336
doelligeriae 734
dryinum 336
lychnidis 946
periclymeni 336, 907
pomi 754, 832, 883, 1005, 1014, 1045, 1138
pseudotsugae 838
Lesion Nematodes 406
Lespedeza 933
Lethal Disease Decline 1092
Lethal Yellowing 133, 991
Lettuce
(Lactuca) 933
Anthracnose 95
Big Vein 934
Big Vein Varicosavirus 637
chlorosis 749
Drop 526
Infectious Yellows 749, 783, 934, 960, 1087, 1134
Infectious Yellows Closterovirus 637

Mosaic 745, 777, 788, 795, 865, 870, 934, 1061, 1082, 1087, 1121
Mosaic Potyvirus 637
Speckles Mottle 749, 934, 1082
Speckles Mottle Umbravirus 637
Lettuce Serotype 969
Leucojum (Snowflake) 935
Leucospermum 935
Leucostoma 249
cincta 249, 266, 719
kunzei 266
persoonii 266
Leucothoë 935
Leucothoë
Leaf Spot 345
Leveillula 445
taurica 445, 755, 774, 821, 830, 867, 891, 897, 902, 962, 985, 1012, 1035, 1111
Lewisia (Bitterroot) 935
Liatris (Gayfeather) 936
Lightning Injury 427
Ligustrum 936
Lilac
Blight 117
Leaf Blight 181
Mildew 445
Mottle 937
Mottle Carlavirus 637
Ring Spot 937
Ring Spot Carlavirus 638
Shoot Blight 200
Witches' Broom 937
Witches' Broom Phytoplasma 638
Lilac (Syringa) 936
Lily
Botrytis Blight 159
Color Adding 638
Color Removing 638
Fleck 638, 938
Latent Mosaic 638, 938
Mottle 938
Mottle Potyvirus 638
Ring Spot 938
Ring Spot = Cucumber Mosaic Cucumovirus 639
Rosette 639, 938
Symptomless 938
Symptomless Carlavirus 639
X 938
Lily (Lilium) 937
Lily-Of-The-Valley (Convallaria) 938
Lima Bean
Mild Mottle 745
Pod Blight 172
Scab 598
Limacinula anomala 140
Limb Blight 167, 168
Limber Neck 937
Lime
Anthracnose 87, 90, 92
Sulfur 22
Lime-Induced Chlorosis 428
Limonomyces roseipellis 885
Linaria (Blue Toadflax; Butter and Eggs) 939
Linden
Anthracnose 84
Basswood (Tilia) 939
Leaf Blight 165
Spot Anthracnose 599
Linnaea (Twin-Flower) 940
Linospora 185, 336
brunellae 1039
gleditschiae 336
gleditsiae 907
psederae 715
tetraspora 185, 1030
Linzites betulina 981
Lions-Ear (Leonotis) 940
Lippia
Spot Anthracnose 600
Lippia (Fog-Fruit, Lemon-Verbena) 940
Lipstick Vine (Aeschynanthus) 940
Lirula 379
abietis-concoloris 182, 378
macrospora 379
nervata 378

Lisianthus (Eustoma grandiflora) 940
Lithocarpus (Tanbark Oak) 941
Lithophragma (Woodland-Star) 941
Lithospermum (Gromwell, Puccoon) 941
Litsea (Pond-Spice) 941
Little Leaf 429, 711, 723, 737, 792, 859, 883, 942, 952, 1001, 1005, 1027, 1131
Little Peach 1027
Littleseed Alfalfa Dodder 274
Lobelia (Cardinal-Flower, Blue Lobelia) 941
Locust
  Witches' Broom 639, 942
Locust (Robinia) 942
Lodgepole Pine Dwarf Mistletoe 370
Loganberry 943
Loganberry Dwarf 639, 754, 832
Lolium Latent 889
Lolium Latent Potexvirus 640
Lomatium (Biscuit-Root) 943
London
  Plane Canker 243
Longidorus
  elongatus 399
  maximus 399
Longidorus and Paralongidorus 398
Longidorus sp. 1021, 1079
Lonicera
  Infectious Variegation 640
Loose Bud 913
Loose Kernel Smut 586
Loosestrife
  Fringed (Steironema) 943
  Moneywort (Lysimachia) 943
Lophiostomataceae 55
Lophodermella 185
  cerina 1019
  concolor 378
Lophodermella sp. 185
Lophodermina
  prunicola 799
  septata 1084
Lophodermium 336, 379
  autumnale 861
  consciatum 861
  decorum 861
  dracaenae 839
  durilabrum 379, 1020
  filiforme 379, 1084
  heteromeles 1017
  juniperinum 379, 916, 925
  lacerum 861
  laricinum 930
  laricis 930
  nitens 379, 1020
  piceae 379, 861, 1084
  pinastri 379, 1020
  ponderosae 1020
  schweinitzii 336, 1049
  seditiosum 379, 1020
  thujae 726
  uncinatum 861
Lophodermium sp. 825, 930
Lophophacidium hyperboreum 1083
Loquat
  Scab 573, 574
Loquat (Eriobotrya) 943
Lotus (Nelumbo) 944
Louisiana Broomrape 223
Louisiana Lettuce Disease 120
Lucuma (Canistel, Egg-Fruit) 944
Ludwigia (False Loosestrife) 944
Lunariae 906
Lupine
  (Lupinus) 944
Luteovirus 72
Lychee 946
Lychnis (Campion) 946
Lycium (Desert-Thorn, Christmasberry) 946
Lycoris 946
Lyonia (Maleberry, Fetterbush, Staggerbush) 947
Lysiloma 947
Lythrum (Winged, Purple Loosestrife) 947

Maackia 947
Macadamia 947
Machlomovirus 73
Macluravirus 73
Macrophoma 249, 337, 493, 884
  candollei 249, 337, 760
  cupressi 249, 825
  cylindrospora 1016
  diospyri 1014
  fici 858
  halstedii 936
  pandani 994
  parca 860
  phacediella 904
  philodendri 967
  phoradendron 249
  rubi 1045
  sphaeropsispora 880
  straminella 1050
  taxi 1142
  trichosanthis 882
  tumefaciens 249
  vincae 1126
Macrophoma sp. 493, 779, 886, 920, 953, 1052
Macrophoma spp. 1137
Macrophomina 185, 493
  phaseoli 704, 732, 743, 749, 768, 770, 778, 800, 804, 808, 815, 821, 826, 841, 849, 884, 899, 928, 938, 945, 951, 954, 956, 960, 983, 985, 998, 1004, 1012, 1017, 1021, 1035, 1058, 1068, 1074, 1078, 1097, 1102, 1112, 1123, 1133, 1144
  phaseolina 185, 493, 713, 881, 969, 1077, 1079, 1085, 1087, 1093, 1097, 1109
Macrosporium baccatum 910
Madrone (Arbutus menziesii) 948
Magnaporthe 493
  poae 494, 887, 888
Magnesium Deficiency 429
Magnolia 948
  Leaf Spot 350
  Scab 598
Mahogany (Swietenia) 949
Mahogany Browning 1034
Mahonia (Oregon-Grape) 949
Maianthemum 950
Mainsia rubi 832
Maize
  Chlorotic Dwarf Virus 1009
  Chlorotic Mottle 814
  Chlorotic Mottle Machlovirus 640
  Dwarf Mosaic 814, 889
  Dwarf Mosaic Potyvirus 640
  Rayado Fino 814
  Rayado Fino Marafivirus 640
  Stripe 814
  Stripe Tenuivirus 640
  Stunt = Maize Chlorotic Dwarf Waikavirus 640
  White Line Mosaic 641
Malachra 950
Malacothrix 950
Malampsora
  abieti-capraearum 553
Mallotus 950
Mallow
  Garden (Malva) 950
Malva
  Vein Clearing 951
  Vein Clearing Potyvirus 641
Malvastrum (False-Mallow, Bush-Mallow) 951
Malvaviscus 951
Mamianiella
  coryli 329
  fimbriata 329
Mancozeb 22
Maneb 22
Manfreda (Spice-Lily, Wild Tuberose) 951
Manganese Deficiency 429
Mango
  Scab 598

Mango (Mangifera) 951
Mangrove (Rhizophora) 952
Manihot (Cassava, Manioc) 952
Manzanita (Arctostaphylos) 952
Maple
  Anthracnose 90, 92
  Brown Leaf Blister 297
  Canker 264
  Inflorescence Blight 166
  Leaf Blister 295
  Leaf Spot 113, 115, 350, 359
  Wilt 693
Maple (Acer) 953
Marafivirus 73
Marah 955
Maranta (Calathea) 955
Marasmiellus pigmentatus 500
Marasmius
  oreades 284, 886
Marasmius spp. 745
Maravalia (Scopella) 567
Maravalia sapotae 567
Marginal Blight 114
Marginal Browning 429, 1034
Marginal Leaf Blight 1005
Marginal Scorch 1027
Marguerite (Argyranthemum frutescens) 955
Marigold
  Leaf Spot 362
Marigold (Tagetes) 955
Mariposa-Lily, Globe-Tulip (Calochortus) 956
Marsh-Marigold (Caltha) 956
Marshelder (Iva xanthifolia) 956
Marsonina
  brunnea 1031
Marssonina 337
  adunca 873
  apicalis 1137
  baptisiae 741
  californica 1130
  callae 774
  coronaria 817
  daphnes 328, 337, 828
  delastrei 337, 814, 1070
  fraserae 811
  fraxini 337
  grossulariae 881
  juglandis 337
  kriegeriana 1137
  lonicerae 907, 979
  martini 980
  melonis 959, 1133
  neilliae 979
  ochroleuca 337, 794
  panattoniana 846, 933
  populi 337
  potentillae 1036
  rhabdospora 338
  rhamni 763
  ribicola 823
  rosae 338, 1052
  thomasiana 850
  tremulae 338
  truncatula 338, 954
  violae 1127
  wyethiae 1140
Marssonina juglandis 902
Marssonina sp. 728, 753, 927
Marssonina spp. 1031, 1137
Massaria 249
  platani 249, 1025
Mastigosporium 338
  rubricosum 338, 887
Matelea 957
Matricaria (False Chamomile) 957
Matrimony-Vine (Lycium halimifolium) 957
Maurandya 957
Mauritius-Hemp (Furcraea) 957
May-Apple (Podophyllum) 958
Meadow-Beauty (Rhexia) 958
Meadow-Rue (Thalictrum) 958
Meadowsweet (Filipendula) 958
Measles 219, 720
Medeolaria farlowii 916
Medicago (Black Medic) 959

Medlar (Mespilus) 959
Megalonectria pseudotrichia 858
Melaleuca 959
Melampodium (Melampodium divaricatum) 959
Melampsora 552
  abieti-capraearum 862, 988, 1137
  abietis-canadensis 553, 898
  albertensis 838, 1032
  arctica 553, 1064, 1137
  bietis-canadensis 1032
  epitea 1137
  euphorbiae 1085
  farlowii 553, 898
  hypericorum 553, 1060
  larici-populina 553, 930, 1021, 1032
  medusae 536, 553, 930, 1032
  medusae f. sp. deltoidae 554, 839, 1021
  medusae f. sp. deltoidea 930
  occidentalis 554, 1032
  paradoxa 554, 930, 1137
  populnea 1032
  ribesii-purpureae 554, 824, 1137
Melampsoraceae 59
Melampsorella 554
  caryophyllacearum 554, 861
  cerastii 862, 1084
Melampsoridium 554
  betulinum 554, 752, 930
  carpini 909
Melamsoridium
  alni 710
Melanconiaceae 63
Melanconidiaceae 56
Melanconis 250
  alni 709
  juglandis 250, 1130
  stilbostoma 752
Melanconium 338, 494
  fuligineum 494, 884
  pandani 338, 994
Melanorhiza 737
Melanose 474
Melanospora
  (Erostrotheca) 374
  destruens 818
  fallax 713
  multiformis 374
Melanospora sp. 756
Melasmia 338
  falcata 338
  galii 867
  menziesiae 338
  menziesii 738, 961
  rhododendri 1049
Melilotus 959
Meliodogyne sp. 796
Meliola 142
  amphitricha 142, 831, 948, 1047
  bidentata 142, 751, 1062
  camelliae 142, 775
  cookeana 142, 774, 929
  cryptocarpa 142, 882
  furcata 751
  jatrophae 922
  lippiae 142, 940
  magnoliae 142, 948
  manca 1134
  martiana 143
  mitchellae 997
  nidulans 143, 756, 835
  palmicola 143
  tenuis 143, 739
  wrightii 143
Meliola sp. 795, 952, 1060
Meliola spp. 994
Meloderma desmazierii 377
Melogrammataceae 56
Meloidodera 399
  floridensis 399, 1021
Meloidodera javanica 1021
Meloidodera sp. 838
Meloidoderita 399
Meloidoderita sp. 883
Meloidogyne 399, 792
  arenaria 402, 703, 707, 744, 748, 760, 767, 780, 782, 868, 904, 960,

1001, 1003, 1012, 1034, 1043, 1115, 1133
arenaria thamesi 402, 1037
arenaria var. thamesi 963, 1111
chitwoodi 402, 748, 813, 1034, 1111
floridensis 1111
graminicola 402, 808, 979
hapla 402, 703, 704, 717, 741, 744, 748, 760, 772, 780, 806, 808, 813, 828, 841, 851, 864, 868, 873, 875, 904, 934, 956, 960, 963, 964, 969, 1003, 1010, 1012, 1034, 1053, 1059, 1068, 1079, 1083, 1086, 1093, 1111
incognita 403, 703–705, 738, 744, 760, 765, 769, 775, 782, 787, 791, 792, 821, 828, 841, 868, 887, 904, 918, 921, 927, 963, 969, 977, 983, 985, 1001, 1008, 1010, 1012, 1029, 1037, 1056, 1065, 1068, 1076, 1101, 1111, 1133
incognita-acrita 742, 760, 780, 864, 1101
javanica 403, 744, 748, 760, 767, 771, 780, 782, 792, 796, 821, 841, 868, 904, 963, 1001, 1003, 1043, 1058, 1063, 1068, 1074, 1079, 1111, 1133
mayaguensis 717
naasi 887
ovalis 403, 954
partityla 1008
Meloidogyne sp. 704–706, 709, 711–713, 723, 727–730, 732, 734–736, 739, 742, 751, 757, 759, 762, 763, 766, 769–771, 773, 774, 776–779, 784, 785, 788, 791, 795, 797, 799, 802, 806–808, 811–815, 820, 822, 824–827, 833, 834, 837, 839, 840, 843, 845–849, 851, 853, 862, 864–866, 872–874, 876–878, 882, 887, 889, 891–893, 898, 899, 902, 903, 905, 907, 908, 911, 912, 915, 917, 918, 921, 922, 927, 931, 936, 938, 940, 943, 945, 949, 952, 954, 955, 957, 961, 962, 966–969, 973–978, 981, 984, 990, 993, 995, 998, 1005, 1009, 1014, 1016, 1021, 1023, 1024, 1029, 1030, 1032, 1033, 1040–1042, 1051, 1053, 1055, 1057, 1059, 1061, 1063, 1064, 1066, 1068, 1069, 1077, 1083, 1088, 1090, 1091, 1095, 1097–1099, 1103–1106, 1108, 1113, 1114, 1116, 1118, 1120, 1123, 1124, 1127, 1135, 1137, 1141, 1143, 1144
Meloidogyne spp. 720, 729, 731, 733, 740, 750, 764, 771, 781, 795, 800, 801, 809, 829, 831, 837, 845, 859, 865, 871, 875, 880, 883, 890, 901, 905, 914, 921, 923, 928, 929, 937, 939, 941, 942, 972, 989, 991, 993, 996, 997, 999, 1008, 1010, 1015, 1017, 1027, 1034, 1038, 1050, 1056, 1058, 1060, 1069, 1070, 1074, 1081–1083, 1087, 1101, 1120, 1123, 1125–1127, 1131, 1139
Melon
Anthracnose 88
Leaf Curl 961
Leaf Curl Bigeminivirus 641
Muskmelon, Cantaloupe, Cassabra (Cucumis melo) 959
Necrotic Spot 960
Necrotic Spot Carmovirus 641
Root Rot 519
Melothria 961
Melting-out 330–332
Mentzelia (Blazing Star) 961
Menziesia 961
Mercury Toxicity 429, 1053
Meria 250
laricis 250, 930
Meria laricis 930
Merismodes ochracea 264
Merlinius joctus 409, 756
Mertensia (Bluebells, Virginia Cowslip) 961
Merulius hexa-gonoides 1068

Mesembryanthemum (Fig-Marigold) 962
Mesocriconema 390
Mesocriconema (Criconemella) 1125
Mesocriconema xenoplax 391
Mesquite
(Prosopis) 962
Metalaxyl 22
Metalaxyl M 22
Metam-Sodium 22, 28
Metiram 22
Micosphaerella maculiformis var. hippocastani 910
Microbotryum silybum 1108
Microcera coccophila 1007
Microdochium 95
(Fusarium) 592
nivale 592
panattonianum 95
Micropeltaceae 55
Micropeltis 186, 339
alabamensis 339, 948
viburni 186
Microsphaera 445
alni 709, 731, 738, 741, 748, 752, 753, 759, 763, 766, 784, 786, 794, 797, 834, 836, 843, 845, 851, 863, 869, 896, 902, 904, 907–909, 932, 937, 939, 954, 968, 970, 981, 1008, 1025, 1049, 1060, 1077, 1083, 1101, 1115, 1126, 1131, 1138, 1139
alni var. cinnamomi 777
alni var. vaccinii 716, 756, 785, 817, 847, 913, 947, 961, 971, 1136
berberidis 974
diffusa 446, 742, 744, 812, 942, 957, 1075, 1079, 1140
euphorbiae 446, 744, 837, 1055, 1075, 1085
grossulariae 446, 823, 843, 881
penicillata 445, 446, 935
pulchra 446, 836
russellii 989
Microsphaera sp. 847, 929, 945, 1071
Microsphaeropsis concentrica 319
Microspora (Erysiphe) palczewskii 1007
Microstroma 339
brachysporum 1130
juglandis 339, 902, 1007, 1130
tonellianum 792
Microstroma sp. 748
Microthyriaceae 54
Microthyriella 287, 339
cuticulosa 339, 904
rubi 287, 719, 987
Mignonette
(Reseda) 962
Mikania (Climbing Hempweed) 963
Mild Cattleya Color-Break 987
Mild Mosaic 1035
Milesia
darkeri 857
dilatata 858
fructuosa 858, 861
glycyrrhiza 857
laeviuscula 857
marginalis 858, 861
polypodophila 857, 861
polystichi 855
vogesiaca 855
Milesina 555
fructuosa 555
laeviuscula 555
marginalis 555
pycnograndis 555
Milk Thistle (Silybum) 963
Milkwort (Polygala) 963
Mimosa Striped Chlorosis 963
Mimosa Striped Chlorosis Badnavirus 641
Mimosa Wilt 690
Mimosa, Silk-Tree (Albizzia julibrissin) 963
Mimulus (Monkey-Flower) 963
Mint
Anthracnose 600

Crinkle 964
Crinkle Closterovirus 641
Mint (Mentha) 964
Mirabilis
Mosaic 864
Mosaic Caulimovirus 641
Miscanthus 964
Mist Sprayers 30
Mistletoe
Dwarf (Arceuthobium spp.) 965
Mistletoe (Phoradendron) 965
Miyagia pseudosphaeria 1077
MLO 730, 936, 1013, 1045, 1126
Mock-Cucumber (Echinocystis) 965
Mock-Orange (Philadelphus) 965
Mock-Strawberry (Duchesnea) 966
Mollisiaceae 57
Molybdenum Toxicity 430
Mombin
Scab 601
Monarda (Horse-Mint, Bee-Balm) 966
Monardella 966
Moneses (Wood-Nymph) 966
Monilia sitophila 960
Moniliaceae 63
Monilinia 494
(Sclerotinia) 186
amelanchieris 714
azaleae 186, 737
demissa 798
fructicola 186, 494, 712, 714, 721, 724, 792, 794, 798, 884, 976, 1001, 1005, 1027, 1041, 1042, 1046, color plate 16
gregaria 714
johnsonii 186, 894
laxa 186, 495, 711, 721, 723, 792, 794, 976, 1001, 1005, 1026, 1041, 1042
ledi 1135
oxycocci 496, 818
padi 798
rhododendri 186, 792
urnula 497
vaccinii-corymbosi 757
Monilochaetes 497, 579
infuscans 497, 579, 922, 969, 1102
Monkshood
Aconite (Aconitum) 967
Vine (Ampelopsis aconitifolia) 967
Monochaetia 250, 339
compta 1052
crataegi 894
desmazierii 794, 844, 902, 910, 954, 980, 1125, 1139
kansensis 794
mali 250, 719
monochaeta 339
pinicola 1019
rosenwaldia 723
unicornis 825
Monogeminivirus 73
Monographella 95
nivales 592
opuntiae 95
Monosporascus 497
cannonballus 497, 960, 1133
Monstera 967
Montia (Indian Lettuce) 967
Moonflower (Calonyction) 967
Moonseed (Menispermum) 968
Morea 968
Morenoella
angustiformis 142
cliftoniae 764
dothideoides 947
ilicis 903, 917
quercina 340, 980
Morinda
Scab 600
Morinda (Royoc, Indian-Mulberry) 968
Morning-Glory (Ipomoea) 968
Mosaic 704, 707, 708, 713, 715, 716, 722, 759, 770, 778, 795, 811, 815, 819, 837, 840, 846, 848, 866, 879, 880, 882, 890, 897, 902, 908, 927, 966, 967, 969, 977, 982, 995, 997,

1017, 1025, 1057, 1064, 1069, 1074, 1076, 1081, 1092, 1095
Clover Yellow Vein Potyvirus 1040
Moss
Rose (Portulaca grandiflora) 969
Motherwort (Leonurus) 969
Mottle 1036
Mottle Leaf 430, 723, 737, 804
Mountain-Ash (Sorbus) 969
Mountain-Heather (Phyllodoce) 970
Mountain-Holly (Nemopanthus) 970
Mountain-Laurel
Leaf Blight 198
Leaf Spot 341, 350
Mountain-Laurel (Kalmia) 971
Mountain-Mahogany (Cercocarpus) 971
Mountain-Mint (Pycnanthemum) 971
Mountain-Sorrel (Oxyria) 972
Mucilago spongiosa 581, 888, 1094
Mucor 497
mucedo 497, 1112
piriformis 497, 721, 792
racemosus 497, 1102
Mucor sp. 960
Mucor spp. 804
Mucoraceae 51
Mulberry
(Morus) 972
Leaf Spot 342
Mule's Ear Disease 1002
Mullein (Verbascum) 972
Mummy Berry 497
Mushroom
Oyster (Pleurotus) 973
Root Rot 458, 467, 468
Musk-Root (Adoxa) 973
Muskmelon
Fusarium Wilt 690
Mosaic 960
Mosaic = Squash Mosaic Comovirus 642
Vein Necrosis 960
Vein Necrosis Carlavirus 642
Mustard Greens (Brassica juncea) 973
Mustard Mosaic 642
Mycelial Neck Rot 463
Myclobutanil 22
Mycocentrospora 343, 464, 494
acerina 464, 494, 782
verrucosa 343
Mycoleptodiscus 498
terrestris 498, 1078, 1114, 1132
Mycoplasmataceae 130
Mycosphaerella 186, 221, 287, 340, 379, 726, 980
aleuritidis 1118
angulata 340
arachidicola 1003
arachidis 340
arachnoidea 972
arbuticola 948
arbutifolia 798
aurea 823
berkeleyi 340, 1003
Blight 153
bolleana 340, 859, 1056
brassicicola 340, 767, 1119
caricae 995
carigena 902
caroliniana 341, 989
caryigena 341, 1007
cerasella 341, 799
cercidicola 341, 1047
chimaphilae 1040
chimaphilina 1023
citri 341, 803
citrullina 186, 821, 882, 960, 1086, 1133
clintoniana 1049
clymenia 907
colorata 341, 971
confusa 754, 832, 1045
coptis 881
cruenta 341, 744, 746, 1078, 1122
cypripedii 988
dearnessii 215
dendroides 221, 902, 1007
diospyri 221, 1014

effigurata 341, 731
erysiphina 908
fijiensis 187, 740
fragariae 341, 1093
fraxinicola 342, 731
gardeniae 868
gaultheriae 869, 1060, 1138
juglandis 342, 1130
krigiae 928
lageniformis 803
laricina 379, 930
leucothoës 935
liriodendri 342, 1117
louisianae 342, 1093
lythracearum 221, 1030
macrospora 323
melonis 187, 821
molleriana 850
mori 342, 972
myricae 742
nigromaculans 342, 817
nyssaecola 1118
nyssicola 342
opuntiae 768–770
ornithogali 324
pachystimae 990
persicae 1001
personata 342, 883
physostegiae 1018
pinodes 187, 945, 999, 1100
pomi 287, 719, 1041, 1042
pontederiae 1132
populicola 343, 1031
populorum 343, 1031
prenanthis 353
primulae 1051
psilospora 343
puericola 928
punctiformis 1095
pyri 343
rabiei 187
ribis 343, 823, 881
rosicola 343, 1052
rosigena 1052
rubi 343, 754, 832, 1046
sapindii 1076
sarraceniae 773, 1024
sentina 719, 1005
sequoiae 187, 1067
serrulata 994
smilacicola 1072
solani 923
staphylina 1088
stigmina-platani 1025
taxi 1142
tecomae 1115
thalictri 958
tulipiferae 1117
tussilaginis 810
ulmi 844
Mycosphaerella sp. 715, 740, 797, 843, 856, 860, 878, 894, 919, 943, 998, 1038, 1139
Mycosyrinx 585
cissi 802
osmundae 585, 856
Mycovellosiella concors 313
Myocentrospora sp. 850
Myriangiaceae 54
Myrianginella sabaleos 994
Myriangium tuberculans 1007
Myrioconium comitatum 1137
Myriogenospora 187
atramentosa 187
paspali 933
Myrobalan Asteroid Spot 1027
Myrobalan Mottle 1027
Myrothecium 343, 498
roridum 343, 498, 718, 730, 796, 830, 833, 848, 862, 868, 877, 905, 912, 915, 940, 976, 995, 1010, 1074, 1078, 1080, 1091, 1110, 1115, 1133
Myrothecium sp. 498, 751, 1112
Myrovellosiella concors 219
Myrtle (Myrtus) 974
Mystrosporium 187
adustum 188, 918

Myxosporium 188
corticola 719, 1005
diedickei 188, 972
everhartii 188
nitidum 188, 836
Myxosporium spp. 1117

Naccobus 403
aberrans 404
batatiformis 404, 867, 934, 1091
dorsalis 404
Nacobbodera 404
chitwoodi 404, 861, 1084
Nacobbus
batatiformis 748, 767, 769, 782
Naemacyclus niveus 380
Naevia oxycocci 818
Nailhead Spot 305
Nanavirus 73
Nandina 974
Leaf Spot 312
Mosaic 974
Mosaic Potexvirus 642
Stem Pitting 974
Napicladium prosopodium 962
Narcissus
Basal Rot 482
Chocolate Spot 642, 975
Fire 209, 211
Flower Streak 642, 975
Leaf Scorch 301
Mosaic 975
Mosaic Potexvirus 642
Smoulder 524, 525
White Mold 355
White Streak 642
Yellow Stripe 975
Yellow Stripe Potyvirus 643
Narcissus (Daffodil, Jonquil) 974
Nasturtium
(Tropaeolum) 975
Mosaic Potyvirus 643
Near
Wilt 691

Neck Rot 113
Necrotic Spot 1003
Necrovirus 73
Nectarine (Prunus persica var. nectarina) 976
Nectria 251
(Hypomyces) 183
balsameae 860
Beech Bark Canker 251
bulbicola 987
Canker 217, 253, 261
cinnabarina 251, 708, 714, 715, 719, 723, 725, 731, 751, 756, 759, 762, 772, 816, 823, 842–844, 858, 879, 881, 900, 905, 906, 910, 923, 927, 942, 953, 963, 965, 969, 972, 998, 1000, 1005, 1017, 1031, 1052, 1077, 1096, 1139
coccinea 708, 709, 731, 751, 762, 772, 795, 843, 844, 904, 953
coccinea var. faginata 251, 747
desmazierii 252
ditissima 252, 704, 823
fuckeliana 252, 860
galligena 252, 709, 719, 747, 751, 837, 902, 909, 953, 980, 1005, 1031, 1041, 1096, 1118, 1130
haematococca 852, 1011, 1012
ipomoeae 183
magnoliae 253, 948
Nectria sp. 792, 908, 948, 972, 1064, 1099, 1117
Nectria spp. 939, 1020, 1130
Nectriaceae 55
Nectrioidaceae 63
Needle
and Cone Rust 553
Blight 176, 187, 195, 196, 199, 200, 207, 208, 214, 379, 380
Blister Rust 538
Cast 178, 185, 376–381
Cast and Blight 380
Cast or Blight 379
Curl 1021

Rust 536, 555
Spot 380
Needle Blight 196
Nematanthus 976
Nematicide 11
Nematodes 1164
Nematospora 498
coryli 498, 804, 895, 1012, 1030, 1079, 1112
phaseoli 498, 744
Nematostoma 344
artemisiae 728
occidentalis 344
Nemesia 976
Nemesia Ring Necrosis Tymovirus 1123, 1124
Nemophila (Baby Blue-Eyes) 976
Neocosmospora vasinfecta 1079
Neofabraea 253
malicorticis 718, 816, 1004, 1041
perennans 253, 719, 1005, 1041
Neolentinus lepideus 492, 930
Neopeckia 188
coulteri 188, 1019, 1083, 1142
Neottiospora 344
yuccifolia 344, 1142
Neovossia 585
iowensis 585
Nephthytis 977
Nepovirus 73
Nerine (Guernsey-Lily) 977
Nettle (Urtica, Urera) 977
Neurospora 499
sitophila 499, 1006
New York Apple Tree Canker 508, 509
New Zealand Flax (Phormium tenax) 977
New Zealand Spinach (Tetragonia) 977
Nicotiana
tobacum 978
Nicotiana (Flowering Tobacco) 977
Nicrosphaeria
alni 1039
Night-Blooming Cereus (Hylocereus) 978
Nightshade
Silverleaf (Solanum elaeagnifolium) 978
Nightshade, Hairy And Climbing (Solanum sarachoides, S. dulcamara) 978
Nigra Loose Smut 589
Nigrospora 499
Cob Rot 499
oryzae 499, 815, 1112
sorghi 813
Ninebark (Physocarpus) 979
Nitrogen Deficiency 430
Nitrogen Excess 430
Nitrothal-Isopropyl 23
NO_2 956
Nocardia 292
vaccinii 292
Northern Corn Leaf Blight 180
Northern Root-Knob Nematode 402
Northwestern Apple Anthracnose 96
Nostoc commune 824
Nothanguina 404
Nothanguina (orrina) phyllobia 404
Nothanguina phyllobia 978
Nothophacidium
abietinellum 196
Nothoscordum
Mosaic 713, 979
Mosaic Potyvirus 643
Nothoscordum (False Garlic) 979
Nucleorhabdovirus 73
Nuda Loose Smut 591
Nummularia 254
Nummularia discreeta 254
Nummularia discreta 714, 719, 816, 970, 1005
Nursery Blight 197, 599
Nut Rot 462
Nutsedge (Cyperus rotunders) 979
Nymphoides (Floating-Heart) 979

Nyssopsora 555
Nyssopsora clavellosa 555, 725

O_3 956
Oak
  Anthracnose 84, 90
  Bark Patch 224
  Leaf Blister 295
  Leaf Spot 343
  Powdery Mildew 441, 444
  Ringspot 981
  Ringspot Virus 643
  Sheathoid Nematode 395
  Wilt 682
Oak (Quercus) 979
Oat
  Blue Dwarf Marafivirus 643
  Cyst Nematode 396
  Golden Stripe Furovirus 643
  Mosaic Bymovirus 644
Ocotillo, Coach-Whip, Candlewood (Fouquieria) 982
Odontoglossum Ring Spot 987
Odontoglossum Ringspot Tobamovirus 644
Oedema 430, 750, 768, 770, 871, 1010, 1111
Oenothera (Evening-Primrose) 982
Ohia (Metrosideros spp.); also Eugenia, Syzgium and Psidium spp. in Myrtaceae Family 983
Oidiopsis taurica 962, 985, 1111
Oidium 446
  araliacearum 446, 920
  begoniae 446, 750
  caricae 995
  dianthi 446, 780
  erysipheoides 717
  erysiphoides var. crotalariae 819
  euonymi-japonici 851
  euonymus japonici 446
  mangiferae 952
  neolycopersici 1111
  obductum 447, 1025
  pyrinum 447, 817
  tingitaninum 447, 804
Oidium sp. 447, 448, 703, 707, 740, 750, 780, 804, 959, 973, 978, 1015, 1029, 1035, 1074, 1096, 1111, 1113, 1114
Okra
  (Hibiscus esculentus) 983
Oleander
  (Nerium) 983
  Bacterial Gall 119
  Scab 601
Oleocellosis 804
Oligoporus placentus 930
Olive
  (Olea) 984
  Knot 119
  Leaf Spot 320
Olpidium 499
  brassicae 499, 888, 1082, 1094
Omphalia 499
  pigmentata 500, 991
  tralucida 500, 991
Omphalia sp. 819
Oncidium Ring Spot 987
Oncoba 984
Onion
  (Allium cepa) 984
  Bulb Rot 113
  Dowy Mildew 277
  Smudge 468
  Smut 588
  Yellow Dwarf 986
  Yellow Dwarf Potyvirus 644
  Yellow Dwarf, Leak Yellow Stripe, Garlic Common Latent 869
  Yellow Spot 986
Onosmodium (Marbleseed) 986
Onygenaceae 53
Oomycota 48
Oospora
  (Geotrichum) 500
  citri-aurantii 500, 804
  lacti 500

lactis 1112
pustulans 1035
Oospora sp. 721, 859
Ophiobolus
graminis 888
Ophiobolus sp. 786
Ophiodothella 344
fici 859
vaccinii 344, 853, 912
Ophiodothis alnea 709
Ophionectria
balsamea 254
scolecospora 255, 861
Ophionectria (Scoleconectria) 254
Ophiosphaerella 500
agrostis 886, 888
herpotricha 888
korrae 888
narmari 888
Ophiosphaerella sp. 500
Ophiostoma
(Ceratocystis) 682
novo-ulmi 683
ulmi 683
wageneri 466
Ophiostoma sp. 1021
Oplismenus (Basket-grass) 986
Opuntia
Sammons 770
Sammons' Tobamovirus 644
Orange 986
Orange Rust 545, 546
Orchid
(Cattleya) Blossom Brown Necrotic Streak 644
(Cattleya) Mosaic Potexvirus 645
(Cymbidium) Mosaic Potexvirus 645
(Odontoglossum) Ring Spot Tobamovirus 645
(Oncidium) Ring Spot 645
(Vanda) Ring Spot 645
Anthracnose 87
Anthracnose Leaf Spot 92
Brown Rot 113
Fleck 987
Fleck Rhabdovirus 644
Orchids (Dendrobium) 986
Orchids (Imported Species) 987
Orchids (Native Species) 988
Oregano, Sweet Marjoram (Origanum) 988
Ormathodium fici 859
Ornithogalum
Mosaic 707, 778, 868, 913, 1066, 1089
Mosaic Potyvirus 646
Orobanche
ludoviciana 223, 1110
racemosa 1110
ramosa 223, 789, 809, 812, 846, 848, 869, 872, 899, 959, 1032, 1070, 1124
Orobanche sp. 1092
Oryzavirus 73
Osage-Orange (Maclura) 988
Osier, Basket-Willow (Salix) 988
Osoberry (Osmaronia) 989
Ourmiavirus 73
Ovularia 344
aristolochiae 344, 840
asperifolii var. lappulae 929
asteris 734
bulbigera 765, 1063
bullata 1088
decipiens 1044
delphinii 829
edwiniae 922
hughesiana 727
isarioides 1088
lupinicola 945
maclurae 988
nymphaearum 1132
pulchella 344, 886
pyrolae 1040
virgaureae 734
Ovularia sp. 1100

Ovulariopsis sp. 945
Ovulinia 188
azaleae 188, 737, 971, 1048
Owls Clover (Orthocarpus) 989
Oxadixyl 23
Oxalis (Wood-Sorrel) 989
Oxycarboxin 23
Oxydendron (Sourwood, Sorrel-Tree) 989
Oxygen Deficiency, Asphyxiation 431
Oxytetracycline Hydroxide 27
Oyster Mushroom (Pleurotus ostreatus) 990
Ozone Injury 720, 744, 1021, 1034

Pachistima 990
Pachysandra (Japanese-Spurge) 990
Pachysandra Leaf 216, 217
Pacific Dagger Nematode 412
Pacific Wax Myrtle (Myrica californica) 990
Paecilomyces 501
buxi 501, 760
Paintbrush Blister Rust 540
Painted Cup, Indian Paintbrush (Castilleja) 990
Pale Leaf Spot 354, 355
Palm
Areca (Chrysalidocarpus) 991
Bud Rot 512
Coconut (Cocos) 991
Date (Phoenix) 991
Fishtail (Caryota) 992
Forster Sentry (Sentry Palm) Kentia (Howeia) 992
Leaf Spot 345, 346
Mosaic 993
Mosaic Potyvirus 646
Pindo (Butia) 992
Queen, Plumy Coconut (Arecastrum) 992
Rhapis (Rhapis) 993
Royal (Roystonea) 993
Sugar (Arenga) 993
Washington (Washingtonia) 993
Palm (Chamaedorea) 991
Palmetto, Cabbage Palm (Sabal) 994
Paloverde (Cercidium) 994
Pampas Grass (Cordaderia) 994
Panagrolaimus subelongatus 1003
Pandanus (Screw Pine) 994
Panicum
Mosaic 889, 1060
Mosaic Sobemovirus 646
Pansy
Scab 601
Pansy (Viola tricolor) 994
Pantoea
agglomerans 985
ananatis 111, 789, 985
herbicola 111
stewartii 111
Papaya
(Carica) 995
Mosaic 996
Mosaic Potexvirus 646
Ring Spot 961, 1134
Ringspot 996
Ringspot Potyvirus 646
Papery Leaf 875
Papularia odorae 730
Papularia sphaerosperma 730
Papulospora sp. 756
Paralongidorus sylphus 399, 964
Paratrichodorus
allius 409
christiei 409, 738, 787, 804, 817, 883, 887, 985
obtusa 887
pachydermus 410, 826
Paratylenchus 404
(Gracilacus) anceps 772
anceps 404
dianthus 404, 780
elachistus 404, 758
epacris 404
hamatus 404, 787, 859, 883

macrophallus 405, 964
micoletzkyi 405, 956
penetrans 405, 1074
projectus 405, 787, 887, 996, 1084
Paratylenchus sp. 1008
Paratylenchus spp. 1053
Parkinsonia 996
Parodiella
perisporioides 837, 1103
Parrotfeather (Myriophyllum) 996
Parsley (Petroselinum) 996
Parsnip (Pastinaca) 997
Partridge-Berry (Mitchella) 997
Passiflora Latent 998
Passion Flower (Passiflora) 997
Patellariaceae 57
Paulownia (Princess-Tree) 998
Pawpaw (Asimina) 998
Pea
Anthracnose 89, 92
Blight 187
Cyst Nematode 397
Downy Mildew 279
Enation Mosaic 795, 1000
Enation Mosaic Enamovirus 646
Mosaic 1000, 1101
Mosaic Potyvirus 647
Mottle 647, 1000
Root Rot 457
Rust 570
Scab 572, 573
Seedborne Mosaic 1121
Streak 795, 1000
Streak Carlavirus 647
Stunt 1000
Wilt 647, 691, 1000
Pea (Pisum) 998
Pea-Tree (Caragana) 1007
Peach
Asteroid Spot 647, 1002
Calico 647, 1002
Dwarf 648, 1002
Golden Net 648, 1002
Latent Mosaic Viroid 976, 1002
Leaf Curl 296
Little Peach 648, 1002
Mildew 451
Mosaic 648, 711, 724, 976, 1002, 1027
Mottle 648, 1002
Necrotic Leaf Spot 648, 1002
Phony 724
Phony Disease 649, 1002
Red Suture 649, 1002
Ring Spot 711, 724, 799, 1002
Ring Spot Ilarvirus 649
Rosette 649, 711, 724, 955, 1002, 1027
Rosette Mosaic 757, 884, 1002
Rosette Mosaic Nepovirus 649
Rust 568
Scab 571
Shoot Blight 168, 169
Stubby Twig 650, 1002
Wart 650, 1002
Western X-Disease 132, 792, 1092
X-Disease 132, 792, 798, 976, 1000
Yellow Bud Mosaic 711, 724, 1002
Yellow Bud = Tomato Ringspot Nepovirus 650
Yellow Leaf Roll 133, 792, 1002
Yellows 133, 711, 724, 976, 1002, 1027
Peach (Prunus persica) 1000
Peacock Spot 320
Peanut
Early Leaf Spot 310
Leaf Spot 312, 314, 340
Mottle 745, 831, 889, 945, 1004
Mottle Potyvirus 650
Rust 559
Stunt 745, 808, 1004
Stunt Cucumovirus 650
Top Paralysis 1004
Top Paralysis Potyvirus 650
Peanut (Arachis) 1003
Pear
Bark Measles 1006

Decline 1006
Decline Phytoplasma 650
Latent 1006
Leaf Blight 177, 178
Leaf Curl 1006
Leaf Spot 343
Ring-Pattern Mosaic 1006
Scab 578
Stony Pit 651, 1006
Vein Yellows/Red Mottle 1006
Pear (Pyrus) 1004
Pecan
Anthracnose 599
Brown Leaf Spot 312, 314
Downy Spot 341
Leaf Blotch 221
Liver Spot 328
Scab 571
Vein Spot 328
Pecan (Carya illinoensis) 1007
Pedicel Necrosis 1053
Pelargonium
Flower Break 871
Flower Break Carmovirus and Pelargonium Line Pattern Carmovirus 651
Leaf Curl 871
Line Pattern 871
Rust 564
Pellicularia 190, 501
filamentosa 191, 745, 783, 842, 888, 901, 905, 911, 920, 928, 999, 1007, 1079, 1118
filamentosa f. sp. microsclerotia 192
filamentosa f. sp. sasakii 192, 885
filamentosa f. sp. timsii 192
koleroga 193, 718, 738, 753, 766, 780, 795, 803, 816, 823, 836, 842, 849, 850, 858, 879, 881, 882, 891, 892, 901, 904, 907, 917, 931, 936, 968, 991, 1004, 1007, 1013, 1014, 1024, 1026, 1030, 1038, 1041, 1052, 1075, 1099, 1118, 1125, 1128
microsclerotia 858
rolfsii 192
solani 948
Penconazole 23
Pencycuron 23
Penicillium 195, 255, 502
aurantiogriseum 503
bacillosporium 750
digitatum 503, 804
Disease 255
Dry Rot 503
expansum 503, 737, 792, 853, 1014, 1030, 1041
funiculosum 876
gladioli 503, 865, 876, 1065, 1109
hirsutum 911
italicum 503, 804
martensii 732
oxalicum 195, 813, 885
roseum 503, 804, 992
vermoeseni 255, 503, 991–993
Penicillium sp. 195, 732, 775, 782, 819, 1002, 1003, 1012, 1102
Penicillium spp. 721, 749, 818, 884, 913, 918, 938, 960, 975, 986, 1006, 1035, 1093, 1116
Peniophora 503
luna 504
polygonia 472
sanguinea 797
Pennisetum 1008
Penstemon (Beard-Tongue) 1009
Peony
Anthracnose 90
Botrytis Blight 160
Leaf Blotch 219
Leaf Curl 651
Ring Spot 1010
Ring Spot = Tobacco Rattle Tobravirus 651
Peony (Paeonia) 1009
Peperomia 1010
Ring Spot 651
Pepino Mosaic 1113

Pepper
Anthracnose 90, 93
Golden Mosaic 1080, 1113
Leaf Spot 311
Mild Mottle 1012
Mild Mottle Tobamovirus 651
Mild Tigre 1012
Mild Tigre' Bigeminivirus and Pepper Texas Bigeminivirus 652
Mottle 1012
Mottle Potyvirus 652
Spot 120
Strain of Alfalfa Mosaic 652, 1012
Texas 1012
Vein Banding Mosaic 652
Vein-Banding Mosaic 1012
Vine, Cissus (Ampelopsis arborea) 1013
Pepper (Capsicum) 1011
Pepper-Grass, Garden Cress (Lepidium) 1013
Peppermint
Root 483
Perennial
Canker 253, 254, 266, 267
Perenniporia
fraxinophila 479
subacida 518
Periconia maculans 374
Peridermium 555
bethelii 555, 965
ornamentale 555, 862
rugosum 555, 862
stalactiforme 544
weirii 1022
Periwinkle, Madagascar (Catharanthus) 1013
Peronosclerospora sorghi 277, 813, 924
Peronospora 276
antirrhini 277, 1074
arborescens 277, 1037
arthuri 277, 805, 869, 878, 982
calotheca 867, 912
candida 1051
claytoniae 806
corydalis 814
cynoglossi 825
destructor 277, 798, 985, 1069, 1126
dianthicola 277, 780
digitalidis 864
dipsaci 1106
echinospermi 929
effusa 277, 1082
farinosa 278, 1061
farinosa f. sp. spinaciae 1082
ficariae 829, 1044, 1114
fragariae 278, 1092
giliae 873
grisea 278, 1124
hydrophylli 914
lamii 809, 1058
lepidii 1013
leptosperma 278, 728, 1059
linariae 278, 939
lophanthi 278, 707
manshurica 278, 1078
myosotidis 278, 863, 929
oxybaphi 278, 710, 1062, 1121
parasitica 278, 724, 730, 767, 777, 795, 796, 806, 839, 900, 911, 973, 1043, 1091, 1098, 1119, 1129, 1138
phlogina 1016
pisi 279
potentillae 279, 708, 832, 873, 966, 1036
radii 279, 955
rubi 279, 754, 832, 1045
rumicis 279, 1050
schachtii 279, 748, 1104
seymourii 912
silenes 1070
sordida 860, 972
sorghi 279
sparsa 279, 1052, color plates 15, 16
statices 279, 1090
swinglei 1058

tabacina 279, 841, 977, 978, 1011, 1110
trifoliorum 279, 945, 1100
viciae 999
violae 995
whippleae 1135
Peronospora sp. 839, 873, 961
Peronosporaceae 50
Peronspora dicentrae 840
Persimmon
Wilt 681, 682
Persimmon (Diospyros) 1013
Pestalopezia
brunneo-pruinosa 1060
rhododendri 1049
Pestalotia 195, 300, 345, 380, 504, 1007
aquatica 345, 728, 1024
aucubae 345, 736
castagnei 941
cibotii 857
clavata 1072
cliftoniae 345, 764
coccolobae 808
cryptomeriae 820
cycadis 824
decolorata 974
funerea 195, 345, 726, 739, 790, 820, 825, 924, 1024, 1067
guepini 345, 1047, 1106
hartigii 195
kalmicola 971
langloisii 868
leucothoës 345, 935
longisetula 504, 1094
macrotricha 345, 1048
micheneri 726
microspora 380
oenotherae 982
palmarum 345, 991, 993, 994
polychaeta 762
quepini 775
rhododendri 345
scirrofaciens 1063
sphaerelloides 902
swieteniae 949
uvicola 1007, 1008
vaccinicola 853
vaccinii 818, 912, 947
Pestalotia sp. 195, 300, 756, 775, 884, 944, 991, 1014, 1017, 1018
Pestalotia spp. 720, 736, 738, 1047
Pestalotiopsis
aquatica 345
funerea 195, 345
leucothoës 345
maculans 345
microspora 1113
palmarum 346
quepini var. macrotricha 346
sydowiana 346
Pestalotiopsis spp. 891
Pestalozziella 346
subsessilis 324, 346, 872
yuccae 1143
Pesticide 11
Pestuloria
funerea 1142
Pestuloria sp. 1142
Petal Blight 183, 188
Petalostemon (Prairie-Clover) 1014
Petasites (Butter-Bur) 1015
Petiole Rot 707
Petunia 1015
Petunia Vein-Clearing 1015
Pezicula 96, 255
carpinea 255, 909
corticola 255
livida 239
malicorticis 96, 254
pruinosa 255, 714
Pezizaceae 57
Pezizella
lythri 1093
oenotherae 754, 832, 850, 944, 947, 954, 958, 966, 982, 1009, 1046, 1052, 1070, 1073, 1096, 1138
Pezizella (Allophylaria) 346

Pezizella (Discohainesia) oenotherae 347
Phacidiaceae 56
Phacidiella 255
coniferarum 256
Phacidiopycnis
boycei 256
piri 256, 1006
pseudotsugae 898
washingtonensis 719, 721, 816, 1006
Phacidium 195, 347
abietinellum 195, 860
balsameae 196, 860
convexum 1019
curtisii 347, 904, 917
infestans 196, 726, 838, 860, 1019, 1083
sphaerodieum 917
Phaciopycnis pseudotsugae 838
Phaelous schweinitzii 930
Phaeoacremonium 196, 504
aleophilum 504, 883
chlamydosporum 196, 504, 883
inflatipes 504, 883
mortoniae 731
viticola 883
Phaeocryptopus
gaeumannii 375, 838
Phaeocryptopus (Adelopus) 375
Phaeoisariopsis
griseda 334
personata 314, 315
robiniae 326
Phaeolus schweinitzii 515
Phaeoseptoria sp. 886
Phaeosphaerella rhamni 763, 809
Phaeosphaeria 347
maydis 347, 813
Phaeotrichoconis 347
crotalariae 347, 991–993
Phakopsora 555
cherimoliae 555, 791
jatrophicola 555, 922
pachyrhizi 556, 745, 746, 750, 928, 1079
zizyphi-vulgaris 556, 924
Phellinus
everhartii 479
gilvus 515
ingiarius 479
laevigatus 518
pini 479
robiniae 480
robustus 480
weirii 518
Phialophora 196, 504, 692
cinerescens 781
graminicola 196, 885
gregata 464, 692, 795
malorum 504, 721, 1006
Philibertia 1016
Philodendron 1016
Phlebia 504
chrysocrea 504, 981
Phloem Necrosis 133, 800, 844
Phloeospora 196, 347
aceris 348
adusta 196, 806
ampelopsidis 715, 920, 1128
anemones 716
asiminae 998
bigeloviae 1042
celtidis 892
idahoensis 889
multimaculans 1025
osmorhizae 1103
pteleae 909
robiniae 942
salicifoliae 1082
vagnerae 1077
Phloeospora multimaculans 1130
Phlox 1016
Mildew 442
Streak 652
Phlyctema 96, 348
ficuum 348, 859

tiliae 939
vagabunda 96
Phoenix-Tree (Firmiana simplex) 1017
Pholiota 505
adiposa 505, 710, 721, 939, 954, 1031
destruens 1031
Pholiota spp. 1137
Phoma 137, 197, 221, 348, 380, 505
ailanthi 708
anethi 834
antennariae 852
apiicola 505, 787
arachidicola 221, 1003
asclepiadea 766
asparagi 732
betae 505, 749
chrysanthemi 154
conidiogena 197, 760
cydoniae 1041
destructiva 505, 1012, 1112
diospyri 1014
erysiphoides 877
eupyrena 380, 838, 860
exigua 307, 349, 815, 914, 934, 1006, 1060
Fruit Spot 287
fumosa 197
glomerata 197
herbarum 708
hieracii 894
lingam 137, 767, 777, 795, 1043, 1098, 1119
lupini 945
lycopersici 307
macdonaldii 197, 506, 1097
mali 1006, 1041
mammillariae 769
mariae 197, 907
menthae 964
palmicola 993
persicae 1001
piceina 197
Root Rot 505
Rot 505
sclerotioides 197, 959
strobiligena 197
subvelata 882, 1087
terrestris 506, 518, 745, 813
thermopsidicola 1107
tuberosa 1035
weigelae 1135
Wilt 137
Phoma sp. 292, 348, 506, 732, 756, 765, 774, 811, 829, 844, 922, 945, 997, 999, 1003, 1038, 1042, 1044, 1079, 1112, 1126
Phoma spp. 721, 884
Phomopsis 197, 256, 348, 506, 692
acerina 953
alnea 256, 709
ambigua 197, 1004
amygdali 256, 506, 711
arnoldia 842
Blight 173, 198
boycei 256, 860
buddleiae 764
callistephi 734
Canker 256, 257
cinerescens 859
dichenii 997
diospyri 197
discolor 256
Disease 256
elaeagni 256, 842
fokoyae 860
gardeniae 256, 868
japonica 197, 927
juniperovora 197, 726, 789, 790, 825, 924, 1068
kalmiae 198, 971
ligustri-vulgaris 1038
lirella 257, 1126
lokoyae 257, 838
longicolla 198, 816
macrospora 1031
mali 257, 506, 721
montanensis 860

oblonga 198, 844
obscurans 172, 198, 1092, 1094
occulta 198, 726, 1083, 1084, 1108
padina 257, 792
phoenicola 992
pseudotsugae 930
rhododendri 1049
salicina 1137
sarothamni 762
sojae 1079
Stem End Rot 474
tuberivora 1035
vaccinii 198, 506, 756, 757
vexans 198, 841
viticola 348, 883
Phomopsis sp. 257, 292, 506, 692, 737, 738, 747, 754, 762, 775, 794, 812, 818, 822, 844, 852, 864, 866, 902, 904, 915, 922, 949, 951, 953, 969, 994, 1001, 1024, 1038, 1048, 1113, 1125
Phoradendron
(True Mistletoe) 369
californicum 369, 704, 819, 962, 994, 996, 1073, 1088
densum 925
juniperinum 369, 916, 925
libocedri 369
pauciflorum 861
serotinum 369
serotinum (flavescens) 709, 720, 752, 762, 777, 831, 838, 844, 892, 895, 900, 902, 907, 910, 939, 942, 954, 962, 981, 1005, 1008, 1014, 1025, 1026, 1028, 1031, 1064, 1076, 1077, 1081, 1099, 1115, 1118, 1131, 1137
serotinum flavescens 731, 748, 792, 794, 795, 836, 842, 863
tomentosum 369, 844, 892, 962, 981
villosum 369, 709, 794, 910, 952, 981
Phoradendron sp. 803, 825
Phorodendron
serotinum (flavescens) 988
tomentosum 988
Phosphorus Deficiency 431
Photinia (Christmasberry, Toyon and Oriental Species) 1017
Photinia photinicola 1018
Phragmidium 556
americanum 556, 1053
andersonii 816, 1036
fusiforme 556, 1053
horkeliae 919
ivesia 919
jonesii 919
montivagum 556, 1053
mucronatum 556, 1053, color plate 2
rosae-arkansanae 557
rosae-californicae 557, 1053
rosae-pimpinellifoliae 1053
rosicola 557, 1053
rubi-idaei 557, 1046
speciosum 557, 1053
subcorticium 557
tuberculatum 557
violaceum 754
Phragmodothella 257
ribesia 257, 823, 881
Phragmodothis berberidis 1122
Phragmopyxis 557
acuminata 557, 816
Phyctema vagabunda 731
Phyllachora 348
beaumontii 794
domingensis 907
erianthi 1028
flabellum 854
fusicarpa 839
graminis 348, 886
melanoplaca 1123
oxalina 989
punctum 986
sabal 994
simplex 1066

sterigena 734
swieteniae 949
sylvatica 348, 886
texana 704
wittrockii 940
Phyllachora sp. 810, 943
Phyllactinia 448
angulata 448
corylea 448, 709, 714, 725, 731, 741, 748, 752–754, 759, 764, 766, 774, 785, 794, 795, 799, 817, 818, 823, 835–837, 842, 843, 845, 848, 880, 881, 895, 896, 901, 902, 904, 906, 908–910, 939, 942, 954, 966, 972, 981, 989, 998, 1016, 1025, 1037, 1041, 1046, 1053, 1064, 1072, 1106, 1107, 1117, 1131, 1137, 1139, 1141
elaeagni 842
gutata 896
ungulata 845
Phyllactinia corylea 866
Phyllody 1090
Phyllosticta 199, 221, 349
adoxae 706, 973
ailanthi 708
alliariifoliae 776
allii 985
alnea 709
althaeina 349, 703
amaranthi 712
amicta 952
andromedae 1018
andropogonivora 349, 758
anemones 716
anemonicola 716
angelicae 717
anserinae 1036
antennariae 852
antirrhini 349, 1009, 1074
apicalis 1137
apii 787
aplectri 988
apocyni 835
aquilegicola 811
araliae 725, 900
arbutifolia 798
argyrea 842
aristolochiae 840
arnicae 727
asiminae 998
astericola 734
aucubae 349, 736
auerswaldii 760
azedarachis 795
batatas 199, 773, 1101
berberidis 741
betulinum 752
bixae 753
brassicicola 767
bridgesii 941
brunellae 1039
bumeliifolia 765
cacti 770
camelliae 349, 775
camelliaecola 349, 775
caricae-papayae 995
carpogena 832
caryae 902
castanea 794
catalpae 349, 785
ceanothi 786
celastri 753
celtidis 892
cephalanthi 766
cercidicola 1047
chamaeneri 847
chenopodii 1082
chionanthi 866
chrysanthemi 800
circumscissa 350, 723, 799, 1001, 1026
cirsii 802, 1107
cissicola 802
citricola 929
clematidis 806
clethricola 807
concava 770

concentrica 350, 920
concomitans 904
confertissima 844
congesta 221, 1026
convexula 1007
cookei 350, 949
coreopsidis 812
cornicola 836
coryli 896
cotoneastri 815
cryptomeriae 199, 820
cucurbitacearum 821
cucurbitarum 1086
curtisii 765
cyclaminicola 824
cyclaminis 824
cydoniae 815
cyrillae 826
decidua 350, 708, 725, 739, 785, 807, 822, 825, 873, 894, 908, 911, 929, 964, 966, 969, 1071, 1088, 1132
delphinii 829
deutziae 831
diervillae 834
digitalis 865
dioscoreae 1141
discincola 864
dispergens 832
dodecathei 835
dracaenae 839
dracocephali 839
draconis 839
epigaeae 847
eriobotryae 944
erysiphoides 831
euonymi 850
everhartii 725, 900
excavata 901
eximia 894
extensa 850
faginea 748
fatiscens 1132
ferax 945
fimbriata 948
fraserae 811
fritillariae 866
galactis 867
gallarum 1007
garrettii 1067
garryae 869, 1071
gaultheriae 1060, 1139
gelsemii 781
geranii 872
ginkgo 874
globigera 970
glycinea 1078
gordoniae 882
grossulariae 823, 881
guttulatae 989
gymnocladi 927
hamamelidis 350, 1139
helleboricola var. coptidis 881
heraclei 900
heteromeles 1017
hibiscina 901, 983, 1055
hortorum 841, 1110
humuli 908
hydrangeae 350, 914
hymenocallidis 951
ilicis 350
illinoiensis 1064
innumerabilis 714
ipomoeae 968
iridis 918
juliflora 962
kalmicola 350
lagerstroemiae 199, 818
lantanoides 1125
laurocerasi 794
lentisci 1024
liatridis 936
linderae 1081
lindericola 1081
lirodendrica 1117
ludwigiae 944
lupini 945
lychnidis 946

lycii 957
lysimachiae 943
maclurae 988
maculicola 350, 839
macunae 1122
magnoliae 949
malvavisci 951
maxima 350, 1018
medeolae 916
melanoplaca 1123
meliae 795
menispermicola 968
mentzeliae 961
micropuncta 736, 1047
minima 350, 759, 954
minor 1126
mitellae 752
monardae 966
monardellae 966
moricola 972
mortoni 952
multicorniculata 199, 860
myricae 742, 990, 1135
nebulosa 1070
negundinis 759, 954
nerii 983
nigrescens 1127
nyssae 1118
oleae 831, 905
opulasteris 979
orbicula 911
orbicularis 1086
orobella 1100
orontii 878
ovalifolii 1038
pachysandrae 990
pallens 850
palmetto 994
palustris 1088
parkinsoniae 996
paulowniae 998
paupercula 714
penicillariae 350, 1009
persicae 1001
phaseolina 744
phorodendri 965
physaleos 796
physopellae 859
pitcheriana 897
pithecolobii 1024
platani 1025
podophylli 958
praetervisa 939
pruni-avium 792
pseudocapsici 923
pteleicola 909
pteridis 199, 854, 855
punctata 1125
putrefaciens 817
pyrolae 1040
pyrorum 1005
rafinesquii 995
raui 1059
rhamnigena 763
rhexiae 958, 1048
rhododendri 1049
rhoiseda 1096
richardiae 350
roberti 859, 1056
robiniae 942
rosae 1052
rosae-setigerae 1052
ruborum 832
rudbeckiae 879, 1056
saccardoi 350
sambuci 843
sanguinariae 350, 755
sapindii 1075
sassafras 1064
saxifragarum 1064
serotina 792
sojicola 351, 1078
solani 841
solidagnicola 880
solitaria 221, 719, 817
sophorae 1077
sorbi 970
spinosa 1070

staticis 1090
stillingiae 797
subeffusa 1072
symphoricarpi 1075
syriaca 1055
taxi 1142
tecomae 1115
tenerrima 1076
terminalis 904, 935
texensis 1124
tinea 1125
trillii 1115
trollii 1115
tuberosa 730, 766
typhina 786
vaccinii 351, 818, 853
verbasicola 972
verbesinae 1124
vincae-majoris 1126
violae 1127
virginiana 714, 799
wistariae 351, 1139
wyomingensis 847
xanthorhizae 1141
zonata 817
Phyllosticta decidua 851
Phyllosticta sp. 705, 738, 742, 750, 756, 771, 796, 808, 809, 817, 829, 835, 848, 852, 854, 857, 868, 873, 890, 909, 911, 912, 915, 927, 936, 938, 955, 960, 967, 994, 998, 1003, 1009, 1014, 1016, 1024, 1041, 1056, 1057, 1063, 1075, 1085, 1090, 1103, 1118–1120, 1126, 1143
Phyllosticta spp. 754, 894, 949, 980, 987, 1031
Phyllostictina
carpogena 1046
hysterella 1142
pyriformis 987
vaccinii 756
Phymatotrichopsis (Phymatotrichum) 506
Phymatotrichopsis omnivors 506
Phymatotrichum 768
omnivorum 508, 703–706, 708, 710, 711, 713, 714, 717, 722, 724–729, 731, 734, 735, 737–739, 741, 745, 746, 749, 752–754, 760–762, 764–766, 769–771, 773, 775–777, 779–782, 784–786, 788, 790, 791, 793–795, 797, 798, 800, 802, 804, 806, 811, 812, 814, 815, 817–823, 825–829, 831–838, 840, 842, 843, 845–847, 849–853, 859, 863, 864, 866–870, 872–874, 877–882, 884, 889–900, 902–917, 919–922, 925, 927–931, 934, 936, 937, 939, 941–952, 954, 960–962, 966–974, 978, 979, 982–984, 986, 988, 989, 993, 994, 996–999, 1002, 1004, 1006–1010, 1012–1014, 1017, 1018, 1021, 1024–1031, 1033, 1035, 1037–1040, 1043, 1044, 1047, 1049, 1050, 1053–1057, 1059, 1061, 1063–1065, 1067, 1068, 1070, 1071, 1073–1077, 1079–1085, 1087, 1090, 1091, 1096–1104, 1106, 1107, 1112, 1115, 1117, 1118, 1120–1129, 1131, 1133, 1135, 1137, 1139, 1141, 1144
Root Rot 506, 508
Physalis
Mosaic 890
Mosaic Tymovirus 652
Physalospora 199, 257, 508
(Acanthorhynchus) 455
abdita 952
corticis 258, 756
dracaenae 199, 839, color plate 14
fusca 704
glandicola 259, 980
gregaria 199, 1137
ilicis 350, 904, 1138
lepachydis 1047
miyabeana 259, 1136
mutila 508, 721

obtusa 200, 259, 509, 708, 709, 721, 762, 770, 779, 815–817, 881, 906, 936, 944, 970, 980, 1005, 1014, 1041, 1042, 1045, 1052, 1064, 1096
rhodina 259, 509, 721, 749, 770, 779, 839, 858, 952, 980, 1004, 1056, 1118
rhododendri 1049
vaccini 455
Physalospora spp. 951, 953, 987, 1014
Physarum
cinereum 888, 934, 1094, 1102
plumbeum 1102
polycephalum 581
Physarum spp. 787
Physiological 718
Physoderma 352
claytoniana 806
maydis 352, 813
Physoderma sp. 1064
Physopella
(Angiopsora) 557
ampelopsidis 558, 884
compressa 558
Physostegia (False Dragonhead) 1018
Phythiogeton autossytum 786
Phytophthora 200, 259, 279, 352, 509, 692, 748
Blight 200
cactorum 200, 259, 509, 692, 711, 721, 723, 737, 747, 751, 755, 757, 760, 781, 788, 792, 805, 828, 836, 837, 842, 844, 851, 861, 865, 875, 880, 892, 902, 910, 925, 927, 936, 938, 944, 946, 948, 953, 980, 987, 1000, 1002, 1006–1009, 1018, 1021, 1026, 1048–1050, 1074, 1083, 1087, 1093, 1101, 1112, 1116, 1119, 1127, 1131, 1134
cambivora 953, 1018, 1048, 1049
capsici 200, 509, 703, 743–745, 822, 1011, 1036, 1081, 1086, 1104, 1112, 1134
cinnamomi 260, 509, 692, 736–738, 752, 757, 776, 786, 790, 794, 818, 825, 838, 855, 861, 896, 901, 917, 925, 930, 942, 947, 952, 953, 971, 980, 981, 1006, 1021, 1025, 1049, 1083, 1084, 1118, 1121, 1123, 1126, 1131, 1136, 1142
citricola 510, 736, 737, 861, 898, 938, 1021, 1049
citrophthora 200, 510, 711, 723, 737, 760, 792, 804, 907, 925, 1000, 1006, 1009, 1049, 1067, 1134
colocasiae 510, 875
cryptogea 511, 706, 734, 749, 872, 877, 878, 915, 925, 934, 956, 996, 1002, 1035, 1059, 1074, 1084, 1091, 1097, 1112, 1131, 1144
cryptogea var. richardiae 511, 774
drechsleri 511, 749, 861, 872, 1035, 1058, 1112
dreschleri 742, 754, 811, 892, 925, 939, 1021, 1059, 1084
erythroseptica 201, 511, 774, 1035, 1046, 1136
europa 981
foliarum 737
fragariae 511, 1093
gymnocarpa 1140
hedraiandra 1048
hibernalis 1049
ilicis 201, 903
infestans 201, 841, 923, 977, 978, 1015, 1033, 1110, color plate 9
inflata 844, 1049
insolita 1049
ipomoeae 968
lateralis 512, 738, 790, 925, 971, 1018, 1127, 1142
Leaf 201
meadii 206, 906
medicaginis 206
megasperma 512, 729, 732, 768, 782, 816, 905, 1002, 1082, 1091

megasperma f. sp. glycinea 512, 1078, 1079
megasperma var. sojae 1079
nicotianae 206, 757, 800, 864, 1049, 1087, 1136
nicotianae var. nicotianae 512, 865
nicotianae var. parasitica 512, 737, 1010, 1015, 1029
palmivora 512, 736, 757, 833, 901, 902, 920, 952, 971, 991–993, 1010, 1136
parasitica 718, 729, 737, 759, 760, 770, 784, 799, 804, 836, 841, 866, 901, 902, 924, 938, 942, 997, 1011, 1015, 1035, 1050, 1055, 1059, 1067, 1074, 1109, 1112, 1123, 1127, 1143
parasitica var. nicotianae 513, 977, 1021
parasitica var. parasitica 206
phaseoli 279, 744
porri 513, 768
ramorum 352, 763, 772, 775, 783, 799, 809, 838, 856, 907, 910, 912, 941, 948, 952, 953, 980, 1018, 1048, 1068, 1077, 1089, 1125
sojae 513, 1079
syringae 206, 261, 513, 711, 721, 803, 925, 936, 1000, 1018
thalictri 958
torulosum 513
tropicalis 1018, 1048, 1049
Phytophthora sp. 707, 726, 732, 802, 815, 829, 913, 914, 993, 999, 1018, 1029, 1066, 1067, 1082, 1102
Phytophthora spp. 960, 1016
Phytoplasma 75
Phytoreovirus 73
Phytotoxic 12
Pick-A-Back (Tolmiea) 1018
Piedraiaceae 54
Pierce's Disease 883
Pierce's Grape Disease 130
Pieris (Mountain, Japanese Andromeda) 1018
Pigeon Pea (Cajanus) 1019
Pigeon Pea Golden Mosaic 1019
Pigeon Pea Golden Mosaic Begomovirus 652
Piggotia
depressa 717
fraxini 338
negundinis 759, 954
vaccinii 756
Pileolaria 558
cotini-coggyriae 558, 1073
effusa 1096
patzcuarensis 558, 1096
Pine
Branch 226
Brown Spot Needle Blight 215
Canker 227
Cone Rust 541, 544
Little Leaf 509
Needle Cast 379
Needle Rust 538
Sheathoid Nematode 395
Twig Blight 164
Pine (Pinus) 1019
Pine-Pine Gall Rust 545
Pineapple
(Ananas) 1023
Wilt – Associated Closterovirus 653
Wilt-Associated 1023
Pinewood Nematode 390
Pink Head 768
Pink Mold Rot 532
Pink Patch 471
Pink Root 518, 519
Pink Rot 526
Pink Snowmold 592
Pink Watery Rot 511
Pinon Blister Rust 541
Piperalin 23
Pipsissewa (Chimaphila) 1023
Piptoporus betulinus 515
Pirostoma nyssae 352

Pistachio (Pistacia) 1024
Pitch (Branch) Cankers 244
Pitcher-Plant (Sarracenia) 1024
Pith Necrosis 114
Pithecellobium (Blackbead, Catsclaw) 1024
Pithomyces chartarum 886
Pitoporus betulinus 515
Pitted Sap Rot 515, 517
Pitting
  Spot 1034
Pittosporum 1024
Pittosporum Leaf Spot 312
Placosphaeria 352
  graminis 353, 886
  haydeni 353, 735, 880
Plagiostoma
  asarifolia 353, 874
  prenanthis 353
Plane Blight 228
Plane-Tree, Sycamore (Platanus) (American Sycamore, P. occidentalis; California Sycamore, P. racemosa; London Plane, P. acerifolia; and Oriental Plane, P. orientalis) 1025
Plantago
  Mottle 1026
  Mottle Tymovirus 653
Plantain, Common (Plantago) 1026
Plasmapara
  halstedii 292
Plasmodiophora 268
  brassicae 268, 712, 724, 767, 777, 796, 900, 906, 911, 973, 1043, 1091, 1098, 1129
  brassicicola 1119
Plasmodiophoraceae 48
Plasmopara 280, 292
  acalyphae 280, 705
  australis 965
  cephalophora 1018
  cercidis 1047
  crustosa 280
  epilobii 847
  geranii 280, 872
  gonolobi 280, 1062, 1127
  halstedii 280, 729, 778, 788, 802, 808, 848, 851, 877, 879, 915, 919, 956, 1044, 1047, 1056, 1071, 1095, 1097, 1124
  lactucaeradicis 934
  nivea 280, 943, 997
  obducens 915
  pygmaea 281, 716, 899, 967
  ribicola 881
  viburni 281, 931, 1125
  viticola 281, 715, 823, 883, 919, 1128
Platycodon (Balloon-Flower) 1026
Plectospira 513
  myriandra 513, 1112
Plectosporium 206
  tabacinum 206, 745, 914
Pleiochaeta 353
  setosa 353, 870, 945
Plenodomus 261, 513
  destruens 513, 922, 969, 1102
  fuscomaculans 261, 719
Pleochaeta
  prosopidis 452
Pleosphaerulina
  (Pringsheimia) 354
  sojicola 354, 1078
Pleosphaerulina sp. 871
Pleospora 353, 514
  allii 732
  compositarum 929
  fructicola 721, 1006
  herbarum 353, 514, 721, 732, 734, 934, 936, 992, 1082
  hyalospora 999
  lycopersici 1112
Pleospora sp. 803, 975, 1003, 1066
Pleurotus 514
  ostreatus 514, 845, 884, 904, 939, 1014, 1024
  serotinus 710, 752

similis 909
ulmarius 514, 721
Pleurotus sp. 1139
Pleurotus spp. 954, 1100, 1137
Ploioderma
hedgecockii 377
lethale 182, 378
Plum
Line Pattern 1027
Line Pattern = Plum American Line Pattern Ilarvirus 653
Pockets 296
Pox 793, 1002
Rusty Blotch 1027
Wart 134, 136
White Spot 653, 1027
Wild (Prunus americana) 1028
Plum (Garden), Prune (Prunus domestica) 1026
Plumegrass (Erianthus) 1028
Plumeria (Frangipani) 1028
Pockets 1111
Pod 150
Pod and Seed Spot 373
Pod Spot 306, 307, 334, 351, 498
Podocarpus 1028
Podosonaera
pannosa 1053
Podosphaera 448
biuncinata 1139
clandestina 449
jusca 852
leucotricha 448, 720, 817, 1005, 1018, 1041
oxyacanthae 712, 714, 720, 723, 765, 792, 799, 817, 895, 906, 976, 1001, 1005, 1014, 1041, 1063, 1075, 1083, 1136
oxyacanthae var. tridactyla 970, 1027
pannosa 449, color plate 8
tridactyla 450, 711
Podosphaera sp. 815
Poinciana (Caesalpinia) 1028
Poinsettia
(Euphorbia pulcherrima) 1029
Mosaic 1029
Mosaic Tymovirus 653
Scab 601
Pointed Ends 1034
Poison Hemlock (Conium) 1029
Polemonium (Jacobs-Ladder, Greek-Valerian) 1030
Pollaccia saliciperda 573
Polyporaceae 61
Polyporus 514
(Favolus) 477
abietinus Syn. Hirshioporus abietinus 515
adustus 710, 1047, 1099
amplectrens 998
anceps 515
balsameus 515
betulinus 515, 752
dryadeus 515
dryophilus 773
farlowii 773, 972, 1137
gilvus 516, 752, 937, 1099
halesiae 893
hirsutus 710, 797, 874, 970, 1002, 1027, 1048
hispidus 516, 752, 972
lacteus 709, 874, 1002
lucidus 516, 1047
mori 477
mutabilis 1048
olaea 984
pargamenus 516
pulchellus 927
robiniophilus 998
schweinitzii 517, 1021, 1142
spraguei 998, 1141
squamosus 517
sulphureus 516, 710, 773, 861, 1106, 1131
texanus 962
tomentosus var. circinatus 517
tulipiferae 725, 874, 900

versicolor 709–711, 772, 773, 795, 797, 874, 891, 895, 914, 970, 971, 998, 1002, 1027, 1039, 1047
versicolor Syn. Coriolus versicolor 517
Polyporus spp. 721, 726, 731, 739, 748, 752, 785, 790, 792, 794, 805, 825, 836, 838, 843, 845, 850, 861, 884, 892, 898, 903, 904, 907, 909, 910, 916, 930, 940, 942, 948, 949, 954, 981, 1006, 1014, 1021, 1025, 1031, 1064, 1068, 1084, 1096, 1100, 1117, 1119, 1131, 1137, 1139
Polyporus tomentosa 490
Polystomellaceae 54
Pome Fruit Spot Anthracnose 598
Pomegranate
(Punica granatum) 1030
Rot 461
Spot Anthracnose 601
Pond-Spice (Litsea) 1030
Ponderosa
Pine Rust 540
Popcorn Disease 166
Poplar
Aspen, Cottonwood (Populus) 1030
Decline Potyvirus 653
Leaf Spot 337
Mosaic 1032
Mosaic Carlavirus 654
Rust 554
Yellow Leaf Blister 297
Poplar Decline 1032
Poppy (Papaver) 1032
Poppy-Mallow (Callirhoë) 1032
Pops 1003
Poria 517
albipellucida 1068
ambigua 792, 793, 892
carnegieae 769
cocos 518
ferrea 896
ferruginosa 952, 1064
inermis 970
isabellina 998
laevigata 518
luteoalba 518
prunicola 518
punctata 741, 760, 989, 1096
sequoiae 1068
spiculosa 902
subacida 518, 825
vaporaria 726, 804
versipora 917, 947
weirii 518, 726, 838, 861
Poria sp. 769
Poria spp. 721, 731, 739, 790, 794, 836, 861, 884, 904, 909, 930, 941, 942, 949, 954, 992, 1021, 1100, 1131
Porio
ambigua 772
ferruginosa 772
Portulaca 1033
Postharvest Decay 472, 476, 521
Postharvest Rot 497
Postia balsamea 517
Potassium Bicarbonate 23
Potato
A Potyvirus 654
Acropetal Necrosis 654
Anthracnose 86
Apical Leaf Roll 133
Aucuba Mosaic 1035
Aucuba Mosaic Potexvirus 654
Blackleg 107
Bouquet Disease 654
Calico 654, 1035
Corky Ring Spot 1036
Crinkle 654, 1035
Green Dwarf 654
Leaf Blotch 218, 219
Leaf Roll 902, 1036, 1082, 1087
Leaf Roll Luteovirus 655
Leaf Rolling Mosaic 1036
Leaf Rolling Mosaic = Potato M Carlavirus 655
Leaf Spot 312, 313

Leafroll 828, 890, 934, 978, 1113, 1144
Mop-Top 1036
Mottle 655, 797
Purple Top 1035
Rot Nematode 392
Rugose Mosaic 655, 1015, 1036
S Carlavirus 655
Spindle Tuber 1036
Spindle Tuber Viroid 655, 1113
Vein Banding 1036
Vein Banding = Potato Y Potyvirus 656
Virus A 656, 978, 1036
Virus M 1036
Virus S 1036
Virus X 745, 747, 819, 837, 921, 1012
Virus Y 978, 1012, 1121
Wart 293
Witches' Broom 656, 1036
X Potexvirus 656
Yellow Dwarf 827, 879, 1036, 1057, 1127, 1138
Yellow Dwarf Nucleorhabdovirus 656
Yellow Spot 657, 1036
Potato (Solanum tuberosum) 1033
Potentilla (Cinquefoil) 1036
Potexvirus 73
Pothos (Epipremnum) 1036
Pothos, Ivy-Arum (Scindapsus) 1036
Potyvirus 74
Pouts 1003
Powdery Mildew 441, 442, 444, 446, 448–451
Powdery Scab 574
Pratylenchus 405
brachyurus 405, 736, 803, 887, 1003, 1023, 1034
coffeae 405, 775, 796, 883, 1093
crenatus 405
fallax 405, 887
hexincisus 405
minyus 405, 860, 883, 1005
musicola 405, 740, 859, 984, 1131
nannus 405, 1144
negelectus 405, 1034
penetrans 405, 720, 723, 749, 813, 855, 915, 937, 1001, 1011, 1034, 1068, 1084, 1093, 1144
pratensis 406, 718, 720, 744, 757, 760, 762, 767, 777, 800, 824, 829, 841, 859, 873, 880, 883, 887, 905, 914, 937, 938, 945, 949, 974, 987, 1005, 1027, 1053, 1061, 1074, 1091, 1093, 1101, 1111, 1117, 1119, 1127, 1135
safaenis 406, 1079
scribneri 406, 713, 987, 1034, 1053, 1093
sp. thornei 954
subpenetrans 406, 887
thornei 406, 825, 887, 976
vulnus 406, 711, 723, 736, 760, 792, 803, 859, 864, 883, 925, 937, 1001, 1027, 1046, 1053, 1068, 1131, 1137
zeae 406
Pratylenchus sp. 705, 707, 750, 771, 792, 820, 934, 935, 942, 981, 1010, 1016, 1036, 1063, 1101
Pratylenchus spp. 406
Premature Ripening 197
Prenanthes (Rattlesnake-Root) 1037
Prickly-Ash (Xanthoxylum americanum) 1037
Prickly-Poppy (Argemone) 1037
Primrose
Leaf Spot 355
Mosaic 657, 1038
Primrose (Primula) 1037
Privet
Ring Spot 657
Privet (Ligustrum) 1038
Prochloraz 23
Propamocarb 23
Propiconazole 23

Propineb 23
Prospodium 558
appendiculatum 558, 1090
lippiae 558
plagiopus 558, 1105
transformans 558
Protectant 11
Protomyces 292
gravidus 292, 1044
macrosporus 292, 897
Protomycetaceae 52
Prune
(Standard) Constricting Mosaic 657
Constricting Mosaic 1027
Diamond Canker 657, 1027
Dwarf 793, 1027
Dwarf Ilarvirus 657
Prunella (Self-Heal, Heal-All) 1039
Pruning Disease 164
Pruning Wound Canker 261
Prunus
Black Knot 134, 136
Necrotic Ring Spot 793, 1002, 1054
Necrotic Ringspot Ilarvirus 658
Ring Spot 1002, 1087
Psalliota
campestris 284, 886
Pseudeurotiaceae 53
Pseudo Curly Top 1113
Pseudo-peronospora
cubensis 965
Pseudocercospora
abelmoschi 314
cannabina 314
capsellae 314
handelii 314
paederiae 1072
puderi 314
purpurea 219
sordida 165
Pseudocercosporella 354
albida 744
capsellae 315, 354, 767, 796, 973, 1119
Pseudocercosporella spp. 1028
Pseudomassaria
sepincolaeformis 240
Pseudomassaria (Didymella) 240
Pseudomonadaceae 111
Pseudomonas
aceris 113, 759, 953
acernea 953
adzukicola 113, 743
alboprecipitans 113
alcaligenes 877
alliicola 984
andropogonis 113, 759, 795, 807, 813, 1089
angulata 113, 890, 977
asplenii 114, 854
avenae 114, 813
berberidis 114, 741
caryophylli 114, 780, 1089
cattleyae 114, 987
cepacia 114, 984
cichorii 114, 742, 767, 787, 800, 846, 871, 933, 941, 948, 1036, 1048, 1065
coadunata 743
colurnae 895
coronafaciens var. atropurpurea 761
corrugata 114, 1110
delphinii 967
erodii 872
fluorescens 114, 911
fluorescens pv. marginalis 933
gladioli 114, 854
helianthi 729
huttiensis 1109
intybus 846
jaggeri pv. apii 787
lachrymans 763, 882, 959, 1133
lauraceum 772
longifolia 890
maculicola 767, 796, 1119
marginalis 1011
marginata 819, 865, 875, 1109
melophthora 114, 718

morsprunorum 791
ovata 743
pastinacae 997
phaseolicola 746, 928
pisi 1100
primulae 1037
pseudoalcaligenes 115, 1087
pseudoalcaligenes subsp. citrulli 959, 1133
ribicola 115, 823
sesami 115, 1068
solanacearum 115, 740, 743, 784, 815, 826, 841, 871, 905, 913, 915, 956, 975, 1003, 1011, 1015, 1033, 1068, 1078, 1097, 1110, 1144
stizolobii 1122
syringae 115, 119, 711, 718, 723, 730, 736, 743, 746, 767, 788, 791, 803, 813, 835, 844, 846, 853, 901, 915, 919, 927, 928, 936, 948, 965, 971, 976, 983, 998, 1000, 1004, 1011, 1026, 1051, 1058, 1081, 1122
syringae pv. aceris 115
syringae pv. alisalensis 730, 767, 885
syringae pv. angulata 115
syringae pv. apii 116, 787
syringae pv. aptata 116, 748, 975, 1104
syringae pv. coronafaciens 116, 762, 885
syringae pv. coryli 895
syringae pv. delphinii 116, 829
syringae pv. glycinea 116, 1078
syringae pv. helianthi 116, 1096
syringae pv. hibisci 117, 901
syringae pv. lachrymans 117, 821, 1086
syringae pv. maculicola 767, 1119
syringae pv. mori 117, 972
syringae pv. mors-prunorum 117
syringae pv. papulans 118, 718
syringae pv. phaseolicola 118, 743
syringae pv. pisi 118, 998
syringae pv. porri 118, 1069
syringae pv. primulae 118
syringae pv. savastanoi 119, 984
syringae pv. syringae 747, 853, 874, 1086, 1136
syringae pv. tabaci 119, 743, 841, 890, 1110
syringae pv. tagetis 120, 729, 955, 1044, 1071, 1096, 1097
syringae pv. tomato 120, 1110
syringae pv. tonelliana 983
syringae pv. zizaniae 120, 1136
tabaci 120, 785, 977, 1078
viburni 120, 1125
viridiflava 120, 742, 1011, 1029, 1109
viridilivida 120, 933
washingtoniae 120, 993
woodsii 121, 780
Pseudomonas sp. 121, 707, 756, 877, 1045, 1117
Pseudonectria 261
pachysandricola 216
rouselliana 261
Pseudoperonospora 282
celtidis 282, 892
cubensis 282, 739, 763, 797, 821, 882, 960, 961, 1086, 1133
erodii 900
humuli 908
Pseudopezicula 300
tetraspora 300, 884
Pseudopeziza 96
repanda 867
ribis 97, 822, 823, 881
Pseudorhytisma bistortae 356
Pseudosaccharomycetaceae 63
Pseudoseptoria
everhartii 358
obtusa 358
Pseudovalsa 261
longipes 261, 980
Psilocybe agrariella var. vaccinii 818

Psittacanthus macrantherus 981, 1020
Psyllid Yellows 1034, 1111
Ptychogaster sp. 987
Puccinastrum
  sparsum 948
Puccinia 558
  aberrans 1072
  abrupta 878, 1124
  acetosae 1057
  acrophila 1105
  acroptili 558, 789, 1057
  adoxae 706, 973
  agnita 806
  agrimoniae 708
  albulensis 1125
  aletridis 1089
  allii 558, 869, 986
  amphigena 558, 1072, 1143
  andina 1045
  andropogonis 558, 741, 964, 989, 990, 1009, 1014, 1073
  andropogonis var. onobrychidis 945
  andropogonis var. penstemonis 1120
  andropogonis var. polygalina 963
  andropogonis var. xanthoxyli 900, 1037
  anemones-virginianae 716
  angelicae 717, 1105
  angustata 964, 966, 971, 1132
  angustata var. eriophori 1067
  antirrhini 558, 939, 1074
  arachidis 559, 1004
  araliae 875
  arenariae 833, 946, 1063, 1103
  areolata 957
  argentata 706, 973
  aristidae 560, 710, 749, 772, 806, 814, 820, 830, 839, 864, 873, 890, 898, 928, 961, 973, 975, 982, 1013, 1015, 1038, 1043, 1062, 1069, 1070, 1076, 1082, 1124, 1129, 1131
  arnicalis 727
  arundinariae 1072
  asarina 874
  asparagi 560, 732, 986
  asperior 943
  asteris 735
  atrofusca 728, 1059
  atropuncta 765, 1037, 1090, 1123, 1141, 1143
  ballotaeflorae 1059
  balsamorhizae 739, 1140
  bartholomaei 766, 1016
  batesiana 897
  bistortae 717
  bolleyana 843
  bouvardiae 759
  brachypodii var. poae-nemoralis 560
  brandegei 814
  calcitrapae var. centaureae 560
  calochorti 956
  calthae 957
  calthicola 957
  campanulae 776
  canaliculata 560, 808, 979, 1097
  cannae 778, 955
  carduorum 560, 1072, 1108
  caricina 560, 824
  caricina var. grossulariata 881
  caricina var. limosae 1089
  caricina var. uliginosa 889
  caricina var. uniporula 881
  caricis 823
  caricis-shepherdiae 764, 842
  carnegiana 762
  carthami 561, 1058
  castillejae 990
  caulicola 1059
  chelonis 1120
  chloridis 730
  cirsii 802, 1107
  claytoniicola 561
  clintonii 1140
  coelopleuri 717
  cognata 1124
  collinsiae 810
  columbiensis 894

commutata 1122
confraga 1009
conglomerata 1015
conoclinii 561, 708, 851
consimilis 1129
conspicua 897
convolvuli 773
cooperiae 1044, 1143
coronata 561, 730, 764, 842, 880, 888, 893, 1047
crandallii 561, 812, 1075, 1140
crassipes 969
crepidis-montanae 894
cryptanthes 820
cyani 789
cynodontis 561, 888
cyperi 848
cypripedii 561, 988
dayi 943
delphinii 829
dichelostemmae 762
dichondrae 833
difformis 867
dioicae 561, 847, 848, 879, 880, 890, 894, 897, 928, 932, 934, 982, 1037, 1042, 1056, 1067, 1068, 1122
dioicae var. asteris 735, 758
distichlidis 943
douglasii 1017
drabae 839
dracunculi 561
eatoniae var. myosotidis 863
eatoniae var. ranunculi 1045
echeveriae 840
effusa 1128
eleocharidis 851
ellisiana 995, 1128
ellisii 717
emiliae 845
enceliae 845
epilobii 847
erigeniae 893
eriophylii 848
expansa 1067
extensicola var. oenotherae 870
farinacea 1059
fergussoni 1128
festucae 908
flaveriae 561, 772, 778
fraseri 894
gaillardiae 867
gemella 957
gentianae 870
gigantea 847
gigantispora 716
giliae 810, 873
glabella 758
glechomatis 890
globosipes 946, 957
glumarum 888
gnaphaliicola 877
graminis 561, 741, 880, 888, 893, 950
graminis subsp. graminicola 888
grindeliae 735, 801, 848, 880, 890, 915, 1042
grumosa 1090, 1143
gulosa 1030
haleniae 870
harknessii 950, 1090
helianthi 563, 729, 897, 1097
hemerocallidis 828
heterospora 563, 704, 905, 951, 1070
heucherae 563, 752, 863, 901, 941, 1064, 1106
hieracii 563, 846, 893, 894, 917, 928, 950
holboellii 839, 1072, 1129
horiana 563, 800
hydrophylli 914
hyssopi 707
insperata 1037
interveniens 791, 876, 951, 1033
invaginata 882
investita 877
iridis 563, 755, 918, 968

irrequiseta 789
jaceae var. diffusa 563, 789
jaceae var. solstitiales 789
jonesii 943
jussiaeae 944, 1134
koeleriae 741, 950
kuhniae 761, 929
lagenophorae 564, 802, 847, 1067
lantanae 929
lateripes 1057
lateritia 912
leonotidis 940
leveillei 872
liatridis 936
ligustici 717, 943
limosae 943
linkii 1126
lithospermi 852
lobata 905, 1070
lobeliae 941
lygodii 855
macrospora 1072
maculosa 928
magnusiana 716
malvacearum 564, 905, 931, 951
marie-wilsoniae 806
massalis 1097
melampodii 564
melanconioides 835
melanocephala 740
melliflora 1059
menthae 564, 755, 807, 834, 873, 964, 966, 971, 988, 1142
mertensiae 863, 930, 962
mesneriana 764, 809
mesomajalis 807
micrantha 824
millefolii 728, 1059, 1141
monoica 725, 839, 1072
montanensis 741
moreniana 762
nakanishikii 564, 933
nodosa 762
obliqua 1016, 1062, 1127
obscura 1140
oenotherae 758, 805, 847, 878, 982, 1143
orbicula 1037
ortonii 835
oxalidis 950, 989
oxyriae 972
pallidissima 1088
palmeri 1009
panici 1075, 1085
parkerae 824
parnassiae 889
paroselae 1073
pattersoniana 762
pazschkei var. tricuspidatae 1064
pelargonii-zonalis 564, 871
penstemonis 1009
peridermiospora 863
phaceliae 772
phragmitis 564, 1050
physalidis 890
physostegiae 1018
pimpinellae 717, 1103
piperi 888
plumbaria 810, 873, 1017
poae-nemoralis 564, 888
poae-sudeticae 564
poarum 1015
podophylli 958
polemonii 1030
polygoni-amphibii 564, 872, 924
polysora 564, 814, 1028
poromera 717
porphyrogenita 835
porri 798
praegracilis 988
probabilis 1125
psidii 565, 710, 959, 983
pulsatillae 716, 806, 1114
pulverulenta 847, 878
punctata 867
punctata var. troglodytes 867
punctiformis 1107, 1108
pygmaea 565, 888

pyrolae 963
ranunculi 1045
raunkaerii 1056
recedens 1067
recondita 565, 716, 740, 762, 772, 806, 811, 829, 888, 914, 941, 958, 962, 967, 986, 1045, 1057
recondita tritici 565
recondita var. secalis 715
retecta 716
rhaetica 1125
romanzoffiae 1051
rubefaciens 867
rudbeckiae 1056
rufescens 1140
rydbergii 1066
salviicola 1059
scandica 847
schedonnardi 791, 876, 905, 951, 1033, 1055, 1070
scirpi 979
septentrionalis 958
sessilis 918, 950, 1076, 1077, 1095, 1121
seymouriana 715, 767, 835
sherardiana 791, 876, 905, 951
sieversii 873
silphii 1071
smilacis 835, 1072
solheimi 565, 835
sorghi 565, 814, 989
sparganioides 565, 731
sparsum 747
spegazzinii 963
sphaeralceae 876
sporoboli 938
stenotaphri 888
stenotaphricola 566
stipae 735, 801, 848, 880, 890, 1042, 1067
striiformis 566, 888
striiformis f. sp. tritici 1135
stromatica 806
subangulata 762
subcircinata 1067
subdecora 761
substriata 566
substriata (I) 842
symphoricarpi 1075, 1140
tageticola 956
tanaceti 728, 1059, 1106
tanaceti var. dracunculina 566
taneceti 566, 800
tardissima 1063
tenuis 851
thaliae 566, 728, 1107
thlaspeos 725
tolimensis 851
treleasiana 957
tripsaci 786
tumidipes 878, 946, 957
umbilici 1066
vagans 891
vagans var. epilobi-tetragoni 758
valerianae 1122
veratri 847, 1123
verbesinae 706, 1124
vernoniae 919
veronicarum 822, 1125
vertisepta 1059
vesiculosa 716
vilfae 1124
vincae 974, 1127
violae 995, 1128
virgae-aureae 880
virgata 1028
volkartiana 1051
waldsteiniae 742
welfeniae 1105
windsoriae 909
xanthii 808, 1097
yosemitana 873
ziziae 1144
zoysiae 1145
Puccinia sp. 717
Pucciniaceae 60
Pucciniastrum 566
agrimoniae 708

alaskanum 870
americanum 566, 1046
epilobii 566, 866, 878
ericae 896
galii 868
goeppertianum 566, 757, 862, 1136
hydrangeae 566, 898, 914
myrtilli 738, 757, 898, 913, 947, 961
pustulatum 805, 847, 862
pyrolae 1023, 1040
sparsum 753, 952
vaccinii 567, 818, 1049, 1136
Pucciniastrum spp. 1136
Puccinii hieracii 934
Puffing 1111
Pullularia
pullulans 744, 1019, 1110
Pullularia sp. 792
Pullularia spp. 756
Pulmonaria 1039
Pumpkin 1039
Punctodera punctata 887
Puncture Vine (Tribulus) 1039
Purple Blotch 218, 341
Purple Cane Spot 174
Purple Leaf Blotch 222
Purple Leaf Spot 342
Purple Spot 364
Pustular Spot 168, 169
Pycnosystanus azalea 163
Pyracantha
Scab 573, 574
Pyracantha (Firethorn) 1039
Pyrazophos 24
Pyrenochaeta 206, 518
lycopersici 519, 1112
phlogis 206, 1016
terrestris 519, 888, 985, 999, 1013, 1069, 1082, 1102, 1112
venuta 980
Pyrenochaeta sp. 756
Pyrenophora
trichostoma 1136
tritici-repentis 1135
Pyrethrum (Chrysanthemum cinerariifolium, C. coccineum) 1040
Pyricularia 206, 354
grisea 206, 354, 788, 885, 886, 1008, 1051
perenne 886
Pyrifenox 24
Pyrola (Shinleaf) 1040
Pyroquilon 24
Pythiaceae 50
Pythium 207, 519, 692
abappressorium 1135
acanthicum 519
aphanidermatum 519, 729, 745, 829, 841, 871, 881, 885, 891, 915, 960, 978, 995, 1012, 1029, 1043, 1078, 1079, 1085, 1087, 1104
aristorum 745
aristosporum 519
arrhenomanes 519, 834, 841, 843, 888, 919, 924, 979, 1012, 1104, 1112
carolinianum 519, 996
catenulatum 519, 745, 1012
debaryanum 519, 713, 741, 744, 770, 805, 841, 843, 846, 871, 874, 888, 892, 928, 937, 941, 945, 960, 995, 1013, 1029, 1035, 1043, 1058, 1086, 1097, 1116, 1131
deliense 749
dissotocum 519, 745, 871, 1079
graminicola 1012, 1024
helicoides 786, 1012, 1073
heterothallicum 871
hypogynum 901
intermedium 855
irregulare 519, 742, 807, 871, 872, 933, 940, 1012, 1029, 1038
mamillatum 708, 810, 811, 871
mastophorum 520, 771, 787, 847

myriotylum 207, 519, 520, 692, 745, 871, 934, 942, 978, 1003, 1004, 1012, 1110, 1112
oligandrum 777
palingenes 1039
paroecandrum 520, 945
periplocum 519, 960
perniciosum 1029
polymastum 520, 767
polytylum 1039
rostratum 866
splendens 520, 796, 833, 871, 977, 987, 1010, 1012, 1016, 1037
torulosum 1078, 1136
tracheiphilum 692, 935
ultimum 520, 707, 712, 734, 744, 764, 766, 771, 778, 785, 790, 795, 802, 807, 829, 831, 833, 866, 867, 871, 877, 878, 888, 901, 915, 924, 927, 945, 956, 987, 988, 1029, 1083, 1087, 1098, 1103, 1116, 1119
uncinulatum 521, 934
vexans 829, 871
Pythium aphanidermatum 692
Pythium sp. 703, 760, 780, 782, 788, 800, 802, 815, 818, 836, 844, 915, 991–993, 996, 1004, 1040, 1045, 1067, 1069, 1120
Pythium spp. 521, 737, 738, 745, 748, 750, 767, 787, 803, 809, 813, 821, 827, 829, 934, 938, 942, 985, 994, 999, 1011, 1020, 1035, 1050, 1074, 1078, 1081, 1091, 1094, 1100, 1102, 1110, 1132, 1133

Quail
Pea Mosaic Comovirus 658
Quail Pea Mosaic 1095
Quarternary Ammonium Compounds 24, 27
Queen Anne'S Lace, False (Ammi majus) 1040
Quince
Flowering, Japanese, Chinese (Chaenomeles) 1042
Rust 547
Quince (Cydonia) 1041
Quintozene 23

Rabbitbrush (Chrysothamnus) 1042
Radish
Black Root 458
Leaf Spot 305
Mosaic 1043, 1120
Mosaic Comovirus 658
Wilt 691
Yellows 934
Radish (Raphanus) 1042
Radopholus 407
Radopholus similis 407, 710, 736, 739, 740, 771, 774, 775, 777, 781, 784, 803, 868, 891, 921, 944, 949, 994, 1010, 1011, 1016, 1036, 1072
Ragweed (Ambrosia) 1044
Rain-Lily (Cooperia) 1044
Ralstonia (Pseudomonas) solanacearum 718
Ralstonia solanacearum 122, 871, 1033
Rambutan (Nephelium lappaceum) 1044
Ramularia 354
acalyphae 705
actaeae 740
aequivoca 1044
agrestis 995, 1127
andromedae 935
angelicae 717
angustata 738
armoraciae 355, 911
aromatica 1099
artemisiae 1059
arvensis 1036
asteris 734
barbareae 1138
beticola 748, 1104
brevipes 966

brunellae 1039
calthae 956
carthami 1058
celastri 753
centranthi 1121, 1122
cephalanthi 766
cercosphaelloides 1058
cercosporoides 847
chrysopsidis 801
cichorii 846
claytoniae 806
clematidis 806
crepidis 894
cyclaminicola 824
cylindriopsis 947
cynarae 729, 779
delphinii 829
deusta f. sp. odorati 1101
didyma 322
diervillae 834, 1135
dioscoreae 1141
effusa 912
euonymi 850
filaris 1067
gei 873
geranii 872
giliae 873
hamamelidis 1139
hedericola 920
heraclei 900
hydrophylli 914
lactea 995, 1127
lappulae 825
liriodendri 1117
lophanthi 707
lupini 945
lysimachiae 943
macrospora 776, 1053
menthicola 964
mimuli 964
mitellae 752
mitellae var. heucherae 901
momordicae 739
monilioides 1099
multiplex 817
nemopanthus 970
obducens 1140
orontii 878
oxalidis 989
pastinacae 355, 997
penstemonis 1009
philadelphi 966
primulae 355, 1038
pruinosa 1067
pusilla 345
pyrolae 1040
ranunculi 716
repens 725
reticulata 1103
rhei 1050
rosea 1137
rubicunda 950
rudbeckiae 879, 1047, 1056
salviicola 1058
sambucina 843
saururi 1064
senecionis 1067
serotina 880
sidalceae 791
sidarum 1070
smilacinae 1077
sphaeroidea 1125
sphaerpioides 1107
spiraeae 979
stachydis 1088
subrufa 1072
tanaceti 1106
ulmariae 878
vaccinii 756
vallisumbrosae 355, 974
vancouveriae 1122
variabilis 355, 865, 973
variegata 1015
veronicae 822, 1125
viburni 1125
waldsteiniae 742

Ramularia sp. 728, 758, 782, 835, 881, 917, 937, 1014, 1016, 1038, 1064, 1100, 1105, 1119
Ramularia spp. 875, 1094
Ramulispora 355
sorghi 355, 886
sorghicola 924
Ranunculus
(Buttercup, Crowfoot) 1044
Mosaic 1045
Mottle 1045
Mottle Potyvirus 658
Raphanus raphanistruno 768
Raspberry
(Red) Mosaic 659
Alpha Leaf Curl Luteovirus 658
Beta Leaf Curl 754, 832
Beta Leaf Curl Luteovirus 658
Bushy Dwarf 1046
Cane Blight 184, 185
Decline 659
Leaf Curl 1046
Leaf Spot 362
Mosaic 832
Ringspot 754
Ringspot Nepovirus 659
Spur Blight 174
Streak 659, 754, 1046
Yellow Mosaic 1046
Yellow Mosaic = Rubus Yellow Net Bednavirus 659
Raspberry (Black) Necrosis 659
Raspberry (Rubus) 1045
Rasutoria abietiis 141
Rathayibacter rathayi 885
Ratibida (Prairie Coneflower) 1047
Ratoon Stunt 103
Rattan Vine (Berchemia) 1047
Ravenelia 567
annulata 947
arizonica 962
australis 704, 913
dysocarpae 567
fragrans var. evernia 567
gooddingii 704
gracilis 1024
hieronymi 704, 913
holwayi 962
humphreyana 567, 770, 1028
igualica 704
indigoferae 567
laevis 916
leucaenae 932
lysilomae 947
morongiae 1065
opaca 907
pithecolobii 1024
reticulatae 774
roemerianae 704
siderocarpi 1024
siliquae 704, 913
subtortuosae 704
texensis 765
thornberiana 704
versatilis 704
Red
Blotch 301
Brown Heart Rot 515, 516
Clover Vein Mosaic 795, 808, 933
Clover Vein Mosaic Carlavirus 660
Fire Disease 301
Heart Rot 529
Leaf 1005
Leaf Gall 293, 294
Leaf Spot 290, 301, 308, 331, 332, 363
Mottle Rot 518
Raspberry Mosaic 754, 1046
Ray Rot 514, 515
Ring Rot 478, 479
Stem Spot 219
Red-Bay, Swamp-Bay (Persea borbonia) 1047
Redbud Leaf Spot 341
Redbud, Judas-Tree (Cercis) 1047
Redweed (Melochia) 1048
Rehmiellopsis balsameae 207, 860
Reniform Nematode 408

Rhabdocline 380
pseudotsugae 380, 838
pseudotsugae subsp. pseudotsugae 838
weirii 381, 838
Rhabdogloeum
abietinum 860
hydrophyllum 838
Rhabdospora 261
mirabilissima 1020
rubi 262
Rhexia (Deergrass, Meadow-Beauty) 1048
Rhizina 521
undulata 521, 838, 898, 930, 1019
Rhizobiaceae 98
Rhizoctonia 207, 356, 521, 693
bataticola 521, 942
crocorum 521
microsclerotia 1017
oryzae 999
ramicola 207, 818, 842, 849, 853, 904, 1024, 1039, 1048
solani 208, 356, 522, 693, 703, 705, 707, 708, 712, 715, 724–726, 729, 730, 732–734, 737, 738, 742, 744, 748, 750, 754, 757, 760, 764, 766–768, 771, 772, 774, 776, 778, 780, 782, 784–788, 795, 800, 802, 803, 805, 807–810, 812, 813, 815, 821, 822, 827–829, 831–834, 838, 841, 844, 846, 851, 853, 854, 858, 862, 865, 870, 871, 874, 876, 878, 880, 881, 885, 892, 898, 900, 904, 912, 914, 915, 917, 918, 920, 928, 930, 931, 934, 937–939, 941, 942, 945–948, 952, 953, 956, 960–962, 967, 973, 977, 978, 982, 983, 985, 987, 988, 994, 996, 997, 999, 1001, 1004, 1007, 1010, 1011, 1013, 1015, 1019, 1020, 1024, 1026, 1029, 1032, 1033, 1038, 1040, 1043, 1044, 1046, 1048, 1050, 1055, 1057–1059, 1061, 1062, 1066, 1067, 1069–1071, 1074, 1077, 1078, 1081, 1084, 1085, 1087, 1090, 1091, 1093, 1097, 1098, 1100, 1102–1104, 1107, 1109, 1110, 1116, 1117, 1119, 1121, 1123, 1125, 1127–1129, 1131, 1133, 1134, 1141, 1142, 1144, 1145
solani Ag-7 1134
tuliparum 522, 918, 938, 1116
zeae 1104
Rhizoctonia sp. 208, 521, 730, 833, 855, 856, 859, 862, 868, 958, 1010, 1037, 1058, 1085
Rhizoctonia spp. 782, 1003
Rhizoctoniose 501
Rhizomania 749
Rhizome Rot 483, 525, 527
Rhizomonas suberifaciens 121, 934
Rhizopus 208, 523
arrhizus 523, 749, 876
nigricans 523, 721, 737, 859, 1001, 1006, 1046, 1093
oryzae 523, 1097
Rot 523
stolonifer 208, 523, 713, 729, 745, 768, 792, 804, 821, 841, 851, 891, 945, 960, 975, 986, 999, 1012, 1014, 1087, 1112, 1116
Rhizopus sp. 938
Rhizopus spp. 711, 749, 782, 997, 1004, 1035, 1102, 1133
Rhizosphaera 381
Rhizosphaera kalkhoffii 381, 1083, 1084
Rhodesgrass (Chloris gayana) 1048
Rhodochytrium spilanthidis 879
Rhodococcus fascians 103, 705, 776, 897, 911, 976, 1123, 1124
Rhododendron 1048
Leaf Gall 290
Leaf Spot 313, 314, 336, 345, 346, 349, 350
Necrotic Ringspot 971, 1049

Necrotic Ringspot Potexvirus 660
Wilt 692
Rhodotorula 288
glutinis 721
Rhoeo 1049
Rhopalidium cercosporelloidis 906
Rhubarb
(Rheum) 1050
Anthracnose 87, 93
Chlorotic Ring 1050
Chlorotic Ring Spot 660
Crown Rot 110
Ring Spot 660
Rhubard Downy Mildew 279
Rhynchosia Golden Mosaic 978, 1080
Rhynchosia Golden Mosaic Begomovirus 660
Rhytidhysteron rufulum 216
Rhytisma 356
acerinum 356, 759, 954
andromedae 356, 715, 932, 947, 971, 1018
arbuti 948
bistorti 356
concavum 1138
decolorans 935, 947
ilicincola 1141
ilicinicolum 904
ilicis-canadensis 970
liriodendri 356, 1117
prini 1138
punctatum 356, 759, 954
salicinum 356, 1137
vaccinii 853, 912, 1135
velatum 904
Rhytisma sp. 961
Ribbon-Bush (Homalocladium) 1050
Ribbon-Grass (Phalaris) 1050
Ribgrass
Mosaic Tobamovirus 660
Ribgrass Mosaic 1026
Rice
(Oryzae sativa) 1051
Root-Knob Nematode 402
Rice-Paper
Plant (Tetrapanax) 1051
Rickettsialike bacteria 104
Rickettsialike organism 885
Ring Nematode 390, 391
Ring Rot 498
Ring Spot 320, 340, 432, 707, 890, 945, 1010, 1027, 1034, 1074
Ripe Fruit Rot 87, 499
Ripe Rot 90, 92, 468, 480, 499
Robinia
Brooming 660, 907
Rock-Jasmine (Androsace) 1051
Rock-Rose (Cistus) 1051
Rodopholus similis 1028
Rodotorula glutinis 288
Roesleria 523
hypogaea 523, 884
Rohdea 1051
Rollinia 1051
Rolstonia solanacearum 121
Romanzoffia 1051
Root and Basal Rot 480
Root and Butt Rot 477, 478, 490
Root and Crown Rot 472, 483, 492, 510
Root and Leaf Rot 502
Root and Pod Rot 525
Root and Seed Rot 484
Root and Stalk Rot 475, 476
Root and Stem Rot 498, 502, 512, 513, 519, 522, 525
Root Girdle 782
Root Lesions 483
Root Rot 152, 240, 456, 461, 466, 468, 471–473, 475, 477, 479, 481, 483, 484, 490, 497, 501, 510–522, 526, 527, 532, 533
Root, Stalk, Pink Kernel Rot 480
Root, Stolon, and Petiole Rot 504
Root-Knob Nematode 402, 403
Root-Rot 523
Rootlet Necrosis 513

Rose
– Acacia (Robinia hispida) 1054
– Mallow (Hibiscus palustris) 1055
(Rosa) 1051
Anthracnose 599
Blackspot 144
Brand Canker 231
Brown Canker 234
Canker 246
Commom Canker 230
Dieback 241
Downy Mildew 279
Graft Canker 231
Leaf Curl 1054
Mildew 449, 452
Mosaic 661, 1054
Rosette 661, 1054
Spring Dwarf 1054
Streak 661, 1054
Yellow Mosaic 661, 1054
Rose-Gentian (Sabatia) 1055
Rose-Of-Sharon, Shrub-Althaea (Hibiscus syriacus) 1055
Roselle
(Hibiscus sabdariffa) 1054
Rosellinia 208, 524
(Dematophora) necatrix 1060
caryae 902
herpotrichioides 208, 837, 898, 1083
necatrix 524, 721, 737, 884, 906, 1039, 1126
Rosellinia sp. 1128
Rosemary (Rosmarinus) 1055
Rosette 432, 720, 737, 902, 977, 1008
Rosy
canker 1025
Rot 124, 511
Rot Root 206
Rotylenchulus 408
reniformis 408, 868, 921, 969, 1111
Rotylenchus 408
blaberus 408, 1081
brachyurus 807
buxophilus 408, 741, 760, 1010
cristiei 408, 887
reniformis 815, 1003
robustus 408, 738
uniformis 408
Rouge-Plant (Rivina) 1056
Rough Bark 1025
Rubber-Plant (Ficus elastica) 1056
Rudbeckia (Golden-Glow, Coneflower, Black-Eyed Susan) 1056
Rue Anemone (Anemonella) 1057
Ruellia 1057
Rugose Mosaic 1113
Rumex (Garden Sorrel) 1057
Rumple 804
Russeting 1111
Russian
Knapweed (Acroptilon repens) 1057
Russian-Olive
Silverberry (Elaeagnus) 1058
Rust 432, 541, 553, 554, 558, 560, 563–566, 568, 570, 875
Rutabaga 1058
Rymovirus 74

Saccardia quercina 981
Safflower
(Carthamus) 1058
Sage (Salvia) (Includes Blue, Clary, Sauceleaf, Scarlet, Black Ornamental Forms) 1058
Sage-Brush (Artemisia) 1059
Saguaro
Cactus Carmovirus 661
Saguaro Cactus 769
Sainfoin (Onobrychis) 1059
Salal (Gaultheria shallon) 1060
Salpiglossis (Painted-Tongue) 1060
Salsify
Black (Scorzonera) 1061
Salsify (Tragopogon) 1061
Salsify Leaf Blight 214, 215
Salt Bush (Atriplex) 1061
Salt Injury 432

Saltgrass (Distichlis) 1062
Salvinia (Aquatic Fern) 1062
Sanchezia 1062
Sand Burn 1008
Sand-Myrtle (Leiophyllum) 1062
Sand-Verbena (Abronia) 1062
Sandvine (Ampelanus) 1062
Sandwort (Arenaria) 1063
Sanguisorba (Burnet) 1063
Sansevieria (Bowstring-Hemp, Snake Plant) 1063
Sapodilla (Achras) 1063
Sapwood
  Rot 470, 492, 517, 528, 529
  Wound Rot 529
Sarcinella heterospora 966
Sarcotrochilia balsameae 196
Sassafras 1064
Satellivirus 74
Saururus (Swamp-Lily, Water Dragon) 1064
Sawadaea
  bicornis 954
  tulasnei 954
Saxifrage (Saxifraga) 1064
Scab 485, 579, 580, 598
Scabiosa 1065
Scald 353, 432, 487, 488, 720, 949, 985, 1005, 1034
Scaly Cap 492
Scarborough-Lily (Vallota) 1065
Schefflera
  (Brassaia actinophylla = Schefflera actinophylla) 1065
  Dwarf (Schefflera arboricola) 1065
  Ringspot 1065
  Ringspot Badnavirus 662
Schiffnerula pulchra 142
Schirrhia 208
Schizonella 585
Schizophyllum 524
  commune 524, 704, 709–711, 719, 721, 724, 726, 731, 748, 752, 772, 773, 785, 786, 805, 845, 884, 903, 907, 909, 940, 954, 962, 972, 981, 1006, 1008, 1014, 1024, 1032, 1064, 1068, 1096, 1100, 1117, 1131, 1137
Schizothyrium 357
  gaultheriae 357, 869, 1139
  pevexiguum 287
  pomi 140, 357
Schizoxylon macrosporum 953
Schrankia 1065
Scilla (Squill) 1065
Scindapsus 1066
Scleroderris 262
  abieticola 262, 861
  lagerbergii 262, 1019, 1020
  lateritium 262
Sclerophoma
  eustomonis 852
  pythiophila 197, 924
Sclerophoma sp. 904
Sclerophthora macrospora 283, 886
Scleropycnium 209
  aureum 209, 962
Sclerospora 282
  farlowii 283, 886
  graminicola 283
Sclerotinia 262, 357, 524, 693
  (Whetzelinia) 209
  borealis 888
  bulborum 913, 918
  camelliae 211, 775
  homeocarpa color plate 10
  homoeocarpa 357, 525, 885, 886, 888, 1003
  intermedia 525, 745, 783, 787, 1061
  minor 211, 525, 693, 725, 742, 745, 753, 768, 782, 783, 787, 795, 808, 841, 846, 853, 899, 911, 934, 945, 979, 982, 1003, 1004, 1012, 1035, 1070, 1074, 1078, 1104, 1112, 1122, 1136
  narcissicola 525, 975
  polyblastis 211, 974
  ricini 745

rolfsii 211, 852, 987, 1121
sativa 1116
sclerotiorum 211, 262, 525, 526, 706, 711, 717, 718, 721, 724, 726, 729, 732, 735, 737, 742, 745, 749, 750, 755, 758, 766, 768, 771, 775, 776, 778, 779, 782–784, 787, 788, 795, 796, 800, 802, 804, 808, 811, 812, 815, 821, 822, 825, 827, 829, 834, 840, 846, 847, 853, 858, 862–865, 867, 870, 872, 874, 875, 877, 879, 883, 899, 905, 913, 934, 936, 938, 939, 945, 951, 956, 960, 962, 967, 973, 974, 983, 986, 996, 997, 999, 1000, 1003, 1004, 1006, 1010, 1012, 1013, 1015, 1018, 1024, 1029, 1035, 1038, 1040, 1043, 1045, 1056, 1058, 1059, 1061, 1065, 1067, 1069, 1074, 1078, 1079, 1082, 1087, 1091, 1093, 1097, 1098, 1101, 1106, 1112, 1114, 1116, 1120, 1121, 1128, 1134, 1144
sclerotiorum = Whetzelinia sclerotiorum 1098
smilacina 875
trifoliorum 527, 808, 820
Sclerotinia sp. 972, 998, 1035, 1045, 1102, 1104, 1110, 1116
Sclerotiniaceae 57
Sclerotium 211, 527, 593
bataticola 211, 942
cepivorum 527, 986, 1069
deciduum 725, 752, 855, 856
delphinii 799, 829
hydrophilum 211, 1136
oryzae 211, 1136
rhizodes 211, 593, 888
rolfsii 211, 527, 708, 713, 716, 718, 729, 734, 736, 738, 744, 746, 748, 750, 755, 765, 767, 770, 771, 774, 776, 777, 779, 780, 782–785, 788, 791, 795, 796, 800, 803, 812, 815, 821, 825–829, 833, 839, 841–843, 846–848, 851, 858, 864, 865, 875, 877, 879, 886, 890, 894, 899, 900, 905, 912, 913, 915, 916, 918, 922, 934, 937–941, 943, 945, 946, 956, 960, 966–968, 974, 985, 987, 991, 994, 995, 997, 999, 1002–1004, 1009, 1011, 1013, 1016, 1018, 1024, 1033, 1039, 1045, 1050, 1052, 1055–1061, 1065, 1066, 1069, 1070, 1074, 1078, 1086, 1089–1093, 1097, 1100, 1101, 1103, 1104, 1106, 1108, 1110, 1115, 1116, 1118, 1119, 1121, 1122, 1125, 1127, 1130, 1133, 1135, 1138, 1143, 1144
rolfsii var. delphinii 735, 1039
Sclerotium sp. 828, 885, 920, 975, 1059, 1132, 1143
Scoleconectria cucurbitula 255
Scolecosporiella sisyrinchii 184
Scolecosporium
fagi 794
Scolecotrichum 357
graminis 358, 886
typhae 786
Scopella sapotae 567, 1063
Scorch 84, 300, 433, 790, 836, 910, 918, 937
Scoria spongiosa 1094
Scorias 595
spongiosa 595, 710, 1023, 1128
spongospora 748
Scribner's Meadow Nematode 406
Scurf 576
Scutellonema 408
blaberum 408
brachyurum 409
brachyurus 707, 713
bradys 409
christiei 409
Scytinostroma galactinum 471
Sea-Grape
Dove-Plum (Coccoloba) 1066
Sea-Kale (Crambe) 1066

Seashore Paspalum (Paspalum) 1066
Seaverinia 527
geranii 527, 872
Sedum (Stonecrop) 1066
Seed 198
Decay 520
Mold 353, 363
Smut 488
Spotting 999
Seed Pitting 744
Seedling
Leaf Blight 326
Root Rot 521
Seedling Blight 88, 150, 159, 167, 174, 179, 186, 208, 216
Seimatosporium
arbuti 320
berckmansii 168
lichenicola 168
Seinhorst
Stubby Root Nematode 410
Seiridium (Coryneum) 232
Seiridium cardinale 232
Seiridium unicorne 250
Selenophoma 358
donacis 730, 740, 886
donacis; Syn. Pseudoseptoria everhartii 358
everhartii 358, 886
obtusa 358, 886
Selenophoma spp. 987
Sempervivum (Houseleek) 1067
Senecio (Groundsel) 1067
Septobasidiaceae 60
Septobasidium 262
alni 1099
apiculatum 1099
burtii 263, 892, 1042, 1099
castaneum 263, 775
cokeri 747, 1040
conidiophorum 775
curtisii 263, 747, 850, 906, 1130
filiforme 709
fumigatum 939
langoisii 948
leprieurii 948
mariani 1040, 1042, 1099
peckii 709
pilosum 951
pseudopedicellatum 263, 723, 775, 797, 844, 935, 951, 965, 1072, 1099, 1118
retiforme 792
sabal-minor 994
sabalis 994
sinuosum 826, 853, 1099
sydowii 892
tenui 948
Septobasidium sp. 971
Septobasidium spp. 731, 739, 747, 759, 803, 836, 858, 894, 902, 904, 908, 909, 917, 953, 980, 1005, 1020, 1118
Septocylindrium 358
hydrophylli 358, 914
ranunculi 1044
Septocylindrium sp. 1099
Septocyta ruberum 262
Septogloeum 359
acerinum 359
celtidis 892
cercocarpi 971
convolvuli 773
defolians 980
hedysari 1103
lupini 945
maculans 1137
oxysporum 359, 886
parasiticum 359, 844
profusum 844, 896
querceum 980
rhopaloideum 359
salicinum 1137
salicis-fendlerianae 1137
schizonoti 906
subnudum 1072
variegatum 709
Septomyxa affine 1119

Septoria 212, 222, 300, 359
abortiva 968
aceris 759, 954
acetosella 989
aegopodii 1103
agrimoniae 708
agrimoniae-eupatoriae 708
agropyrina 222, 359, 886
alabamensis 785
alba 1071
albicans 1064
albopunctata 756, 853
allardii 765
alni 709
ampelina 883
anemones 716
angularis 734
angustifolia 971
antirrhinorum 957
apii 212
apii-graveolentis 212
apiicola 212, 787
aquilegiae 810
arabidis 724
araliae 874
argemones 1037
argyrea 842
artemisiae 1059
asiminae 998
asplenii 856
atropurpurea 850
azaleae 300, 738
baptisiae 741
bataticola 359, 1101
betae 748
betulae 752
betulicola 752
blasdalei 763
breviuscula 940
brunellae 1039
bumeliae 765
cacaliae 1067
cacticola 769
calamagrostidis 359, 887
callistephi 359, 734
calypsonis 988
calystegiae 773
campanulae 776
canadensis 835
cannabis 899
carthami 1058
caryae 902, 1007
cassiicola 784
ceanothi 786
cephalanthi 766
cercosperma 877, 894
chamaecisti 1098
chelidonii 786
chimaphilae 1023
chionanthi 866
chlorogali 775
chrysanthemella 359, 800, 827
chrysanthemi 814
cirrhosa 1088
cirsii 802, 1107
citri 360, 803
citrulli 360
clematidis 806
cocoina 992
collinsiae 810
consocia 963
conspicua 943
convolvuli 773, 968
coptidis 881
coreopsidis 812
cornicola 360, 836
corydalis 814
corylina 896
crataegi 894
cruciatae 867
cucurbitacearum 360, 821, 960, 1086
cunilae 834
cyclaminis 360
cylindrica 716
cylindrospora 1140
dalibardae 827
darlingtoniae 773

darrowi 754, 832, 1046
dearnessii 717
delphinella 829
dianthae 780
dianthi 360, 833, 1103
didyma 1137
diervillae 834
dimera 1070
divaricatae 360
dracocephali 839
elaeagni 842
eleospora 866
elymi 222, 886
epilobii 847
erigerontis 848
erigerontis var. boltoniae 758
eriobotryae 944
eryngicola 849
euonymi 850
eupatorii 851
eupatoriicola 851
exotica 896
expansa 872
farfaricola 810
fici-indicae 770
flagellaris 773
flagellifera 999
gaillardiae 867
gaurina 869
gei 873
glabra 910
gladioli 360, 876
glycines 360, 1079
grindeliae 889
grindeliicola 889
helenii 897
helianthi 729, 897, 1097
heliopsidis 897
hepaticae 899
heucherae 901
hicoriae 902
hieracicola 894
hippocastani 910
humuli 908
hydrangeae 914
hydrophylli 914
hypoxis 1089
ilicifolia 904
increscens 1089
infuscata 1047
iresines 917
jussiaeae 1134
krigiae 928
lactucae 361, 788, 934
lamii 969
lanaria 852
lavandulae 931
Leaf Spot 360, 361
lepachydis 840
leucanthemi 213, 800, 827, 1069
liatridis 936
limonium 803
linariae 939
liquidambaris 1099
lithospermi 941
littorea 835
lobeliae 941
loligena 361, 887
lophanthi 707
ludwigiae 944
lupinicola 945
lupulina 908
lychnidis 946
lychnidis var. pusilla 814
lycopersici 361, 841, 1110
lycopi 1132
lythrina 947
macropoda 222, 886
maculifera 822
magnoliae 949
malvicola 905
margaritaceae 715
mariae-wilsonii 1120
menthae 964
menthicola 755
mentzeliae 961
mikanii 963
mimuli 964

mitellae 752
musiva 1070
myricae 1135
myricata 1099
nabali 1037
negundinis 759
nepetae 785
noctiflorae 1076
nodorum 887
noli-tangeris 915
obesa 359, 800
oedospora 1075
oenotherae 982
oleandrina 983
ornithogali 1089
ostryae 908
oudemansii 361, 887
pachysandrae 990
pachyspora 900, 1037
paeoniae 361, 1010
pastinacae 997
penstemonis 1009
peraphylli 1088
petroselini 996
petrosellini 213
philadelphi 966
phlogis 361
photiniae 1017
phylctaenioides 807
physostegiae 1018
pileae 730
pimpinellae 1105
pisi 999
pistaciarum 361, 1024
platanifolia 1025
pleosporioides 1057
polemonii 1030
polemoniicola 1030
polygalae 963
populicola 361, 1031
poseyi 961
pruni 799, 1026
pteleae 909
pulchella 947
punicea 716
pyri 817
pyrolae 1040
ravenelii 794
rhapontici 1050
rhododendri 1049
rhoina 1073, 1096
rivinae 1056
rosae 1052
rubi 361, 754, 832
rudbeckiae 879, 1056
salicicola 1137
sambucina 843, 907
sanguinea 823
scrophulariae 860
scutellariae 1071
secalis 887
secalis var. stipae 362
sedi 1066
selenophomoides 987
senecionis 1067
shepherdiae 764
signalensis 1075
silenes 1070
sitchensis 970
smilacinae 1077
smilacis 1072
solitaria 738, 1049
sorbi 970
spadicea 1019
specula riae 1080
spiculosa 1071
spraguei 362
stachydis 1088
stigma 1100
streptopidis 1095
symphoricarpi 1075, 1139
symploci 1100
tageticola 362, 956
tecomae 1115
tenella 362, 887
thalictri 958
tradescantiae 1114
trautveteriae 1114

trichostematis 757
trillii 1115
triseti 887
tritici var. lolicola 362, 887
ulmariae 958
unedonis 1094
valerianae 1121
valerianellae 1122
verbasicola 973
verbenae 1124
veronicae 822, 1125
vincae 1126
violae 1127
waldsteiniae 742
wistariae 1139
wyethiae 1140
xylostei 907
ziziae 1144
Septoria sp. 739, 779, 815, 866, 874, 890, 912, 919, 927, 952, 1007, 1032, 1044, 1055, 1062–1064
Septoria spp. 880, 965, 980, 1016, 1137
Septorium spraguei 1136
Septosphaeria maculans 778
Septosporium
heterosporum 883
lindquistii 1097
Septotinia 213
podophyllina 213, 958
populiperda 1031
Sequivirus 74
Sequoia (Redwood and Giant Sequoia) 1067
Seriocarpus (White-Topped Aster) 1068
Serrano Golden Mosaic 1012, 1113
Servazziella 213
Servazziella longispora 169, 213
Sesame
(Sesamum) 1068
Sesquicillium buxi 501
Sesuvium 1068
Setaria glauca 885
Setosphaeria turcica 180
Severe Cattleya Color-Break 987
Shallot (Allium ascalonicum; A. porrum, Leek) 1069
Shamrock
Chlorotic Ringspot 989
Chlorotic Ringspot Potyvirus 662
Shasta Daisy (Leucanthemum x Superbum) 1069
Shepherd'S Purse (Capsella) 1069
Shining Willow (Salix lucida) 1070
Shizophyllum commune 1002
Shoot and Leaf Gall 290
Shoot and Stem Blight 200
Shoot and Twig Blight 211
Shoot Blight 175, 179, 182, 186, 198, 214, 378
Shoot Dieback 244, 257
Shoot Hole 316, 318
Shoot Hypertrophy 290
Short-Cycle Orange Rust 552
Shortened Internodes 1143
Shortia (Oconee-bells) 1070
Shot Berry 433, 883
Shot Hole 168, 169, 311, 317, 318
Shrivel 896, 1131
Sickle Leaf 984
Sida 1070
Silene (Catchfly, Cushion-Pink, Campion) 1070
Silk-Tassel Bush (Garrya) 1070
Silky Thread Blight 207
Silphium (Compass Plant, Indian-Cup) 1071
Silver Leaf 528, 529
Silver Scurf 579, 580, 804
Silver Spike Disease 483
Sirococcus 213
clavigignenti-juglandacearum 1130
conigenus 786
strobilinus 214, 1020, 1083
Sirosporium diffusum 314
Sirrococcus elavigignenti-juglandacearum 214

Sirula macrospora 1083
Skimmia 1071
Skin Blanching 883
Skullcap (Scutellaria) 1071
Skunk Vine (Paederia foetide) 1072
Skunk-Cabbage (Symplocarpus) 1071
Slenderflower Thistle (Carduus) 1072
Slight Blight 318
Slime Disease 115, 121
Small Brown Patch 525
Small Flower Galinsoga (Galinsoga parviflora) 1072
Small Sclerotial Neck Rot 463
Smelowskia 1072
Smilax
  Leaf Spot 313
Smilax (Greenbrier Cat-Brier) 1072
Smithantha 1073
Smithiana 1073
Smithiana Potex Virus 662
Smithiana Potexvirus 1073
Smog Injury 433
Smoke Injury 434
Smoke-Tree (Cotinus) 1073
Smoke-Tree (Dalea) 1073
Smooth Patch 224
Smooth-Headed Meadow Nematode 405
Smother 216
Smut 584, 588, 589
Snakeweed (Polygonum) 1073
Snapdragon
  (Antirrhinum) 1073
  Anthracnose 86, 93
  Downy Mildew 277
  Leaf Spot 349
  Rust 558
Snow Blight 196
Snow-On-The-Mountain (Euphorbia marginata) 1075
Snowball Spot Anthracnose 601
Snowberry
  Anthracnose 601
Snowberry (Symphoricarpos) 1074
Snowdrop
  (Galanthus) 1075
Snowmold 593
SO_3 956
Soapberry
  Southern (Sapindus saponaria) 1075
  Western (Sapindus drummondii) 1076
Soapwort (Saponaria) 1076
Sobemovirus 74
Society Garlic (Tulbaghia) 1076
Soft Nose 952, 984
Soft Rot 107, 108, 114, 156, 491, 503, 523
Soft Scald 720
Soggy Breakdown 720
Soil Rot or Pox 529
Solanum Yellows Luteovirus 662
Solenia
  anomala 264
  ochracea 264, 709, 751, 902
Solenia (Henningsomyces) 263
Solomons-Seal (Polygonatum) 1076
Sonchus 1077
  Yellow Net 934
  Yellow Net Nucleorhabdovirus 662
Soot Injury 434
Sooty Blotch of Fruit 219, 220
Sooty Mold 594, 595
Sooty-Bark Canker 228
Sophora (Pagoda Tree, Silky Sophora, Mescalbean) 1077
Sordaria sp. 756
Sordariaceae 55
Sorghum
  Chlorotic Spot 924
  Chlorotic Spot Furovirus 662
  halepense 885
  Mosaic Potyvirus 662
  Stunt Mosaic 814, 924
  Stunt Mosaic Nucleorhabdovirus 662
Sorosphaera veronicae 1124

Sorosporium 585
saponariae 585, 1070
syntherisme 888
Sour Orange Scab 597
Sour Rot 500
Sour Skin Rot 113, 114
South Carolina Lettuce Disease 128, 130
Southern
Bacterial Wilt 115, 121
Bean Mosaic 745
Blight 190, 192, 211, 527
Corn Leaf Blight 180
Corn Rust 564
Fusiform Rust 541
Root-Knob Nematode 403
Squash Mosaic 1087
Southwestern Ponderosa Pine Dwarf Mistletoe 371
Sowbane Mosaic 791
Sowbane Mosaic Sobemovirus 662
Sowthistle Yellow Vein 1077
Sowthistle Yellow Vein Nucleorhabdovirus 663
Sowthistle, Annual (Sonchos oleraceus) 1077
Soy Bean Target Spot 319
Soybean
Cyst Nematode 397
Downy Mildew 278
Dwarf 1080
Dwarf Luteovirus 663
Mosaic 1080, 1095
Mosaic Potyvirus 663
Pod 173
Yellow Mosaic 663, 1080
Soybean (Glycine max) 1078
Spanish
Moss (Tillandsia) 1080
Sparassis radicata 838, 930, 1021, 1084
Sparaxis
(Wandflower) 1080
Mosaic 663
Spathiphyllum 1080
Spearmint Rust 564
Speckeled Tar Spot 356
Speckle 358, 1054
Speckled Leaf Blotch 222
Specularia (Venus Looking-Glass) 1080
Sphacele (Pitcher-Sage) 1081
Sphacelia sp. 924
Sphaceloma 600
araliae 600, 725, 900
cercocarpi 600, 971
hederae 600, 920
lippiae 600, 940
menthae 600, 964
morindae 600, 968
murrayae 1138
murrayi 600
oleandri 601, 984
perseae 601, 737
phaseoli 745
poinsettiae 601, 1029, 1085
populi 1032
psidii 601, 853
punicae 601, 1030
ribis 601, 882
spondiadis 601, 1083
symphoricarpi 601, 812, 1075
viburni 601, 1126
violae 601, 995, 1128
Sphaceloma sp. 751, 785, 843, 1049, 1106
Sphaceloma spp. 601
Sphacelotheca
cruenta 586
reiliana 586, 814
sorghi 586
Sphaerella applanata 806
Sphaerellaceae 55
Sphaerellopsis filum 1114
Sphaeriaceae 55
Sphaerioidaceae 63
Sphaerobolus stellatus 796
Sphaerognomonia carpinea 896, 909

Sphaeronema 409
pomorum 817
Sphaeronema sp. 409, 756, 790
Sphaerophragmium 568
acaciae 568, 932
Sphaeropsis 214, 264, 293
abietis 861
albescens 953
asiminae 998
Canker 258, 259, 264
cruenta 950, 1072, 1076, 1077, 1121
ellisii 1020, 1084
hedericola 920
hyalina 241
pyriputrescens 719, 721, 816, 1006
salviae 1059
sambucina 843
sapinea 175, 214, 264, 1019
tumefaciens 264, 293, 779, 803, 1060
ulmicola 264, 844
visci 965
Sphaeropsis sp. 731, 836, 844, 939, 983, 990, 1093, 1142
Sphaerotheca 450
castagnei 451
dipsacearum 1106
fuliginea 451, 821, 1087
fusca 451, 890
lanestris 451, 981
macularis 451, 707, 708, 727, 751, 752, 754, 764, 765, 802, 810, 822, 829, 832, 843, 847, 848, 863, 867, 872, 873, 880, 881, 894, 901, 908, 914, 919, 957, 958, 964, 979, 990, 995, 1017, 1030, 1036, 1037, 1039, 1044, 1046, 1053, 1063, 1064, 1067, 1083, 1088, 1093, 1096, 1106, 1107, 1125, 1128, 1140
mors-uvae 451, 823, 881
pannosa 711, 723, 957, 976, 1018
pannosa var. persicae 451, 1001
pannosa var. rosae 452
phytoptophila 452, 892
Sphaerotheca sp. 452, 1018
Sphaerulina 362
polyspora 214, 989
rubi 362
taxi 1142
taxicola 1142
Sphenospora 567
kevorkianii 987
mera 567, 987
saphena 987
Spice-Bush (Lindera) 1081
Spider-Lily (Hymenocallis) 1081
Spiderling, Wine-Flower (Boerhaavia) 1081
Spike 1023
Spilocaea
botryae 926
eriobotryae 944
photinicola 574
pomi 574
pyracanthae 574
Spilocaea (Fusicladium) 573
Spinach
(Spinacea) 1081
Anthracnose 87
Blight 663
Downy Mildew 277
Latent 1082
Latent Ilarvirus 663
Smut 584
Yellow Dwarf 664, 1082
Spine Injury 904
Spiraea (Native Hardhack, Meadowsweet) 1082
Spiral Nematode 408
Spiranthes Mosaic 987
Spirea
Oriental Flowering (Spiraea) 1083
Spiroplasma citri 133, 783, 911, 973, 985, 1069, 1138
Splanchrorema platani 249
Spondias (Mombin) 1083

Spondylocladium atrovirens 580, 1035
Spongospora 574
subterranea 574, 1035, 1112
Spongy Root Rot 518
Spongy Sap Rot 477, 478
Spongy Scab 574
Sporgospora
subterranea f. sp. nasturtii 1131
Sporidesmium 214
maclurae 215
Sporisorium 585
cruentum 586
holci-sorghi 586
sorghi 586
Sporobolomycetaceae 63
Sporocybe rhois, Anamorph 233
Sporodesmium
maclurae 988
scorzonerae 215, 1061
Sporonema 362
camelliae 363, 775
oxycocci 817
Sporotrichum
malorum 1006
Sporotrichum sp. 937, 1112
Spot
Anthracnose 597–600
Spot Blotch 330, 332
Spraing 1035
Spraying 30
Spring
Beauty Latent 806
Beauty Latent Bromovirus 664
Dead Spot 887
Dwarf Nematode 386
Sprout Tubers 1035
Spruce
Needle Cast 379
Needle Rust 537, 538
Twig Blight 153
Spruce (Picea) 1083
Spurge
Caper (Euphorbia lathyris) 1085
Cypress (Euphorbia cyparissias) 1085
Flowering (Euphorbia corollata) 1085
Leafy (Euphorbia esula) 1085
Painted (Euphorbia heterophylla) 1085
Prostrate (Euphorbia supina) 1086
Spotted (Euphorbia maculata) 1086
Spy Epinasty Decline 1006
Squash
(Southern) Mosaic 664
Leaf Curl 1087, 1134
Leaf Curl Bigeminivirus 664
Mosaic 960, 1087
Mosaic Comovirus 664
Squash and Pumpkin (Cucurbita) 1086
Squash-Bush (Condalia) 1088
Squaw-Apple (Peraphyllum) 1088
St. Andrews Cross, St. Peterswort (Ascyrum) 1060
St. Augustine Decline Virus 889
St. Augustinegrass (Stenotaphrum) 1060
St. Johnswort (Hypericum) 1060
Stachybotrys
chartarum 1079
Stachybotrys sp. 789
Stachys (Betony, Hedgenettle, Woundwort) 1088
Stagonospora 301
achlydis 1122
apocyni 835
atriplicis 1061
baptisiae 741
cirsii 1107
curtisii 301, 713, 819, 850, 935, 946, 974, 977, 1065, 1081, 1090, 1143
foliicola 1050
gigantea 789, 1143
intermixta 886
petasitidis 1015
phaseoli 744

smilacis 733, 1072
spinaciae 1082
typhoidearum 786
Stagonospora sp. 725, 900
Stagonosporopsis hortensis 307
Stain 985
Stalk Blight 163
Stalk Rot 87, 93, 485
Staphylea (Bladdernut) 1088
Star-Of-Bethlehem (Ornithogalum) 1089
Starbur, Bristly (Acanthospermum) 1088
Starflower
(Trientalis) 1088
Stargrass
(Aletris) 1089
Golden (Hypoxis) 1089
Statice, Sea-Lavender (Limonium) 1089
Steccherinum 527
abietis 528
balloui 790
erinaceus 1025
ochraceum 710, 825, 981, 1096, 1100
pulcherrimum 1100
septentrionale 528, 903, 939, 954
Steccherinum sp. 909
Steccherinum spp. 752
Stegonsporium 264
Stegonsporium acerinum 953
Stegonsporium sp. 264
Stegophora ulmea 329
Steiner's Spiral Nematode 394
Stem
Anthracnose 89
Dieback 115
Stem and Branch Rot 152, 461
Stem and Bud Rot 108
Stem and Bulb Nematode 392
Stem and Foliage Blight 165
Stem and Leaf Blight 179
Stem and Leaf Gall 292
Stem Blight 153, 173, 179, 206, 216, 217
Stem Break 913
Stem Canker 102, 103, 172, 225, 230, 240, 241, 244, 262, 267, 318, 349, 361, 512, 522
Stem End Rot 186
Stem Gall 256, 292, 294
Stem Lesion 152
Stem Necrosis 114, 1035
Stem Pitting 724, 793, 1001, 1002, 1027
Stem Rot 113, 114, 349, 359, 456, 457, 483, 486, 489, 506, 509, 525–527
Stem Rust 561
Stem Spot 120, 305, 306, 330, 332–334
Stem Wilt 483
Stem, Crown and Root Rot 520
Stem-End Browning 1035
Stem-end Rot 311
Stem-pitting 722
Stemphylium 215, 363
Blight 215
bolickii 363, 840, 926, 1066
botryosum 363, 732, 744, 767, 985, 1011, 1015, 1016, 1061, 1082, 1104, 1119
botryosum f. sp. capsicum 1011
callistephi 363
congestum 721
cucurbitacearum 363, 821, 1086
elasticae 1056
floridanum 780, 800, 826, 1111
floridanum f. sp. kalanchoe 926
ilicis 818
Leaf Spot 364
lycopersici 364
polymorphum 999
solani 364, 841, 890, 923, 1011, 1110
vesicarium 215, 364, 732, 985
Stemphylium sp. 363, 715, 758, 787, 863, 875, 882, 897, 996, 1003, 1058, 1128

Stenanthium 1090
Stenocarpella maydis 476
Stenolobium (Florida Yellow-Trumpet) 1090
Stephanomeria (Wire-Lettuce) 1090
Stephanotis 1090
Stereum 528
albobadium 772
bicolor 892
cinerescens 972
fasciatum 529
hirsutum 529, 773, 850, 903, 941, 971, 1002, 1006, 1039
purpureum 529, 721, 724, 752, 793, 937, 1002, 1006, 1027
rameale 971
sanguinolentum 529, 861, 930
taxodii 825
Stereum sp. 721
Stereum spp. 710, 748, 752, 785, 794, 838, 884, 904, 909, 930, 940, 949, 954, 981, 1021, 1068, 1100, 1119
Sternbergia (Fall-Daffodil) 1090
Sterum spp. 1025
Stevia (Piqueria) 1091
Stewart's Disease 110, 111
Sthughesia 143
juniperi 143
Stictidiaceae 57
Stictis araucariae 726
Stictochlorella lupini 945
Stictopatella iridis 918
Stigmatea
geranii 872
rubicola 1046
Stigmatea (Stigmea) 364
Stigmea
geranii 364
rubicola 364
Stigmella
platani-racemosae 365, 1025
vernoniae 919
Stigmina
carpophila 169
juniperina 924
lautii 1083
liquidambaris 365
palmivorum 365
platani-racemosae 365
populi 1031
thermopsidis 1107
Stigmina (Stigmella) 364
Stigmonose 434, 720, 1005
Stilbaceae 63
Stilbella acerina 954
Stillingia (Queens Delight) 1091
Sting Nematode 389
Stinking Smut 586
Stippen 720
Stock
Mosaic 664
Stock (Matthiola) 1091
Stokesia (Stokes-Aster) 1092
Stone Plant (Lithops) 1092
Storage Rot 464, 497, 504
Stranvaesia 1092
Strapleaf 902
Strawberry
Anthracnose 87
Crinkle 1094
Crinkle Cytorhabdovirus 664
Downy Mildew 278
Green Petal 133
Latent Ringspot 964, 996
Latent Ringspot Nepovirus 665
Latent Virus Rhabdovirus 665
Leaf Blight 172, 197, 198
Leaf Curl 665
Leaf Roll 665, 1094
Leaf Scorch 299
Leaf Spot 341
Mild Crinkle 665
Mild Yellow Edge 1094
Mild Yellow Edge Chlorosis Potexvirus 665
Mild Yellow Edge Luteovirus 665
Mottle 665, 1094
Multiplier Disease 666, 1094

Necrotic Shock 1094
Necrotic Shock = Tobacco Streak Ilarvirus 666
Pallidosis 1094
Pallidosis Virus 666
Pallidosis = Cucurbit Yellows Crinovirus and Beet Pseudo-Yellows Closterovirus 666
Phyllody Strawb PhF Phytoplasma 666
Pseudo Mild Yellow Edge 1094
Pseudo Mild Yellow Edge Carlavirus 666
Red Stele Disease 511
Severe Crinkle 666
Stunt 666
Vein Banding 1094
Vein Necrosis 1094
Veinbanding Caulimovirus 667
Witches' Broom 667, 1094
Yellow Edge 667, 1094
Yellows 667
Strawberry (Fragaria) 1092
Strawberry Phyllody 1094
Strawberry-Tree (Arbutus unedo) 1094
Strawflower (Helichrysum) 1095
Streak 357, 358, 938
Streptanthera 1095
Mosaic 667
Streptobotrys arisaemae 163
Streptocarpus 1095
Streptomyces 529, 575
acidiscabies 575, 749, 783, 997, 1043, 1120
ipomoea 529, 922, 969, 1102
scabies 575, 749, 783, 827, 997, 1035, 1043, 1120
Streptomyces sp. 1035
Streptomycin (Nitrate or Sulfate) 27
Streptopus (Twisted-Stalk) 1095
Streptotinia arisaemae 921
Striga asiatica 814
Strigula complanata 735, 923, 949, 950, 954, 957, 981, 998, 1038, 1096, 1128, 1135
Strigula elegans 735, 923, 949, 950, 954, 957, 981, 998, 1038, 1096, 1128, 1135
String Butt Rot 518
String of Pearls 593
Stripe Rust 566
Stripe Smut 589, 591
Stromatinia 530
gladioli 530, 819, 865, 876, 1115
narcissi 530, 974
smilacinae 1076, 1077
Strophostyles (Wild Bean) 1095
Strumella 264
Canker 264, 265
coryneoidea 265, 794, 902, 908, 953, 1118
coryneoides 747, 980
Strumella sp. 939
Stump Rot 122
Stunt 133, 398, 1029
Stunt and Leaf Yellowing 521
Stunting Disease 103
Stylosanthes 1096
Styrax (Snowbell) 1095
Subanguina radicicola 887
Suberranean Clover Red Leaf 808
Subterranean Clover Red Leaf Luteovirus 667
Sugar Beet
Nematode 397
Sugar Beet (Beta vulgaris) 1096
Sugarcane
Bacilliform Badnavirus 668
Mosaic 889
Mosaic Virus 740
Sugarcane Stylet Nematode 410
Sulfur 24
Sulfur Dioxide Injury 1021
Sulfur Injury 434
Sumac (Rhus) 1096
Summer Dwarf Nematode 386

Sunburn 720, 859
Sunflower
(Helianthus) 1096
Mosaic 819, 1098, 1144
Mosaic Potyvirus 668
Rust 538, 563
wilt 682
Sunrose (Helianthemum) 1098
Sunscald 300, 435, 720, 760, 1012, 1049, 1111, 1131
Sunstroke 436
Superficial Bark Canker 255
Suture Spot 1001
Swedish Ivy (Plectranthus australis) 1098
Sweet
Clover Latent 959
Clover Sweet Latent Nucleorhabdovirus 668
Sweet Alyssum (Lobularia) 1098
Sweet Gale (Myrica gale) 1099
Sweet Gum (Liquidambar) 1099
Sweet Pea and Perennial Pea (Lathyrus) 1100
Sweet Pea Streak 1101
Sweet Potato
Black Rot 465
Caulimovirus 668
Dry Rot 474
Feathery Mottle 969, 1102
Internal Cork 1102
Leaf Blight 199
Leaf Spot 359
Mosaic 669, 1102
Russet Crack 1102
Russet Crack – Strain of Sweetpotato Feathery Mottle Potyvirus 669
Scurf 579
Stem Rot 481
Sweet Vetch (Hedysarum) 1103
Sweet William (Dianthus barbatus) 1103
Sweet-Fern (Comptonia) 1098
Sweet-Fern Blister Rust 540
Sweet-Flag (Acorus) 1099
Sweet-Olive (Osmanthus fragrans) 1100
Sweet-Root (Osmorhiza) 1103
Sweetleaf (Symplocos) 1100
Sweetpotato (Ipomoea batatas) 1101
Swine Cress (Coronopus) 1104
Swiss Chard (Beta vulgaris var. cicla) 1104
Swiss Needle Cast 375
Switchgrass (Panicum) 1104
Sycamore 1104
Anthracnose 84
Sydowia 265
dothideoides 242
polyspora 265, 861
Syncarpella tumefaciens 1059
Synchytrium 293
anemones 293, 716
anomalum 706, 973, 1044, 1057
asari 874
aureum 293, 705, 728, 807, 829, 832, 873, 879, 943, 956, 1015, 1037, 1044, 1056, 1067, 1088, 1093, 1122, 1127, 1140
cellulare 971, 1132
cinnamomeum 1044
edgertonii 833
endobioticum 293, 1036, 1113
erigerontis 848
fragariae 1093
fulgens 805, 869, 982
geranii 872
globosum 966, 1124
holwayi 966
impatientis 915
innominatum 950
lythrii 947
marrubii 903
myosotidis 820
nigrescens 734
papillatum 900
sambuci 843
smilacis 1072

stachydis 1088
taraxaci 846
vaccinii 294, 738, 756, 790, 807, 817, 912, 932, 971
Synchytrium sp. 294, 784, 1080
Syngonium 1105
Synthyris 1105
Systoria cyclaminis 824
Systremma 215
acicola 215, 1019
artemisiae 728

Tabebuia (Trumpet-Tree) 1105
Tabernaemontana (Crape-Jasmine) 1105
Taenidia 1105
Tahitian Bridal Veil (Gibasis) 1105
Tamarind (Tamarindus) 1105
Tamarisk, Salt Cedar (Tamarix) 1106
Tan Leaf Spot 344, 345
Tanacetum 1059
Tansy (Tanacetum) 1106
Taphrina 295
aceris 295
aesculi 295, 910
alni 297
amelanchieri 714
americana 752
aurea 1031
australis 295, 909
bartholomaei 953
caerulescens 295, 980
californica 857
carnea 295, 752
carveri 953
castanopsidis 295, 797
cerasi 792, 793
communis 296, 1026
confusa 297, 799
coryli 296, 895
cystopteridis 854
darkeri 953
dearnessii 953
deformans 296, 723, 976, 1001
farlowii 297, 792
faulliana 297, 855
filicina 297, 857
flava 297, 752
flavorubra 297
flectans 297
fusca 857
gracilis 857
insititiae 1026
japonica 297, 709
johansonii 1031
lutescens 857
occidentalis 297, 709
polystichi 855
populi-salicis 1031, 1137
populina 297, 1031
pruni 296, 1026
prunisubcordata 296
purpurascens 1096
robinsoniana 297, 709
sacchari 297, 953
struthiopteridis 297
thomasii 297
ulmi 297, 844
virginica 908
weisneri 297
Taphrina spp. 295, 1026
Taphrinales 52
Taphrinia
filicina 857
higginsii 856
hiratsukae 856, 857
Tar Spot 320, 325, 336, 338, 347, 348, 353, 356, 376, 377, 379
Target Canker 1005
Tarjan's Sneath Nematode 395
Tatter Leaf 799
Tea (Thea sinensis) 1106
Teasel
Mosaic Potyvirus 669
Teasel (Dipsacus) 1106
Teasel Mosaic 1106
Tebuconazole 24
Tellima 1106

Tenuivirus 74
Ternstroemia 1107
Tesselate Stylet Nematode 410
Tetraconazole 24
Tetylenchus 409
Texas Mistletoe 369
Texas Root Rot 506, 508
Texasweed (Caperonia) 1107
Thalia 1107
Thames' Root-Knob Nematode 402
Thanatephonus
  cucumeris 194
Thanatephorus
  cucumeris 194, 501, 502, 748
Thecaphora 586
  californica 890
  Cuneata 890
  cuneata 880
  deformans 488, 945
  iresine 917
  pilulaeformis 1042
  trailii 1107
Thekopsora
  minima 898
Thelephora 216
  albido-brunnea 953
  caryophyllea 930
  spiculosa 216
  terrestris 216, 838, 860, 1019, 1082, 1083
Thelephoraceae 61
Thermopsis (Bush-Pea, Golden-Pea) 1107
Thiabendazole 24
Thielaviopsis 530
  basicola 530, 745, 750, 762, 785, 795, 802, 804, 824, 828, 871, 875, 911, 933, 937, 939, 945, 983, 985, 989, 995, 999, 1004, 1010, 1017, 1029, 1074, 1101, 1112, 1122, 1123, 1127, 1128, 1133
  paradoxa 789
Thielaviopsis sp. 866
Thiophanate
  Methyl 24
  Methyl Plus Etridiazole 24
Thiram 24
Thistle
  (Cirsium) 1107
  Blessed (Cnicus) 1108
  Creeping (Canada) (Cirsium arvense) 1108
  Ivory And Milk (Silybum) 1108
  Musk (Carduus thoermeri) 1108
Thlaspi 1108
Thorn's
  Meadow Nematode 406
  Needle Nematode 399
Thoroughwax (Bupleurum) 1108
Thread Blight 167, 193
Thujopsis (Hiba Arborvitae) 1108
Thunbergia (Clockvine) 1108
Thyme (Thymus) 1109
Thyronectria 265
  austro-americana 265, 906, 907
  balsamea 255, 265, 861
  berolinensis 265, 823
  denigrata 907
Thytisma vaccinii 756
Ti (Cordyline terminalis) 1109
Tibouchina (Glory-Bush) 1109
Tidestrominia 1109
Tigridia
  Mosaic 669, 1109
Tigridia (Tiger-Flower) 1109
Tilletia 586
  buchloëana 586, 764, 888
  caries 586
  euphorbiae 1085
  foetida 586
  fusca 888
  maclaganii 1104
  pallida 587, 888
Tilletiaceae 59
Timber Rot 492
Tip Blight 94, 171, 195, 199, 207, 496, 1074

Tipburn 436, 737, 749, 768, 846, 934, 1035
Tirula nervisequa conspicuous 861
Tithonia 1109
Tobacco
Broad Ring Spot 669
Cyst Nematode 397
Etch 1012, 1015, 1113, 1121, 1144
Etch Potyvirus 670
Mild Green Mosaic 978
Mild Green Mosaic Tobamovirus 670
Mosaic 705, 706, 722, 732, 736, 797, 798, 809, 843, 848, 865, 877, 923, 928, 976, 978, 1012, 1015, 1049, 1080, 1095, 1112, 1121, 1139
Mosaic Tobamovirus 670
Mosaic Virus 731
Necrosis 745, 934, 1038, 1116, 1121
Necrosis Necrovirus 671
Necrotic Ring Spot 955
Rattle 716, 734, 742, 755, 872, 934
Rattle Tobravirus 671
Ring Spot 706, 745, 757, 822, 827, 836, 843, 864, 871, 882, 884, 922, 960, 964, 978, 983, 996, 1012, 1015, 1036, 1046, 1071, 1080, 1087, 1102, 1121, 1134
Ring Spot Nepovirus 671
Ring Spot Virus 731, 736
Ringspot 732, 735, 834, 915
Stread 973
Streak 754, 765, 846, 852, 908, 934, 963, 1043, 1080, 1094, 1113
Streak Ilarvirus 671
Vein Mottling Potyvirus 672
Vein-Banding Mosaic 978
Vein-Mottling 978
Veinnal Necrosis 1036
Wildfire 119
Yellow Net 978
Yellow Net Luteovirus 672
Tobamovirus 74
Tobravirus 74, 1010, 1017
Tobravirus, Leaf Necrosis 912
Togninia fraxinopennsylvanica 731, 883
Tomatillo (Physalis ixocarpa) 1113
Tomato
(Lycopersicon) 1109
Anthracnose 89, 93
Aspermy 801, 1112
Aspermy Cucumovirus 672
Big Bud 672, 1110
Black Ring 1113
Black Ring Nepovirus 672
Bushy Stunt 934, 1113
Bushy Stunt Tombusvirus 673
Chino La Paz 1113
Chino La Paz Begomovirus 673
Enation Mosaic 673
Fernleaf 673
Infectious Chlorosis 1113
Infectious Chlorosis Closterovirus 673
Leaf Curl 722, 1012
Leaf Spot 364
Mosaic 1113
Mosaic Tobamovirus 673
Mottle 1113
Pseudo Curly Top 1113
Pseudo Curly Top Hybrigemini-virus 673
Ring Mosaic 1112
Ring Spot 793, 871, 876, 884, 1002, 1046, 1112, 1121
Ring Spot Nepovirus 674
Ringspot 722, 764, 795, 827, 835, 846, 899, 959, 973, 989, 1026, 1036, 1039, 1057, 1094
Severe Leaf Curl Begomovirus 1113
Spotted Wilt 706, 713, 729, 734, 735, 738, 741, 742, 750, 755, 761, 763, 766, 768–772, 774, 776, 782, 788, 789, 795, 801, 802, 811, 815, 827, 828, 830, 831, 839,

842, 845–847, 850, 852, 854, 863, 865–867, 871, 877, 878, 880, 884, 890, 902, 911, 912, 914, 915, 922, 923, 929, 932, 934, 940, 942, 945, 959, 964, 966, 969, 975, 977, 978, 987, 989, 1000, 1004, 1012, 1015, 1018, 1023, 1030, 1032, 1033, 1036, 1038, 1039, 1043, 1045, 1051, 1057, 1059, 1066, 1067, 1069, 1080, 1082, 1088, 1090, 1091, 1095, 1098, 1101, 1112–1114, 1120, 1124, 1125, 1129, 1134, 1144
Spotted Wilt – Impatiens Serotype 852
Spotted Wilt – Lettuce Serotype 995
Spotted Wilt lettuce serotype 708
Spotted Wilt Tospovirus 674
Spotted Wilt-Impatiens Serotype 865, 872, 876, 1017, 1127
Spotted Wilt-Lettuce Serotype 870, 1109
Streak 1113
Streak Double Streak 675
Top Necrosis 1113
Top Necrosis Neopvirus 675
Western Yellow Blight 675
Yellow Leaf Curl Begomovirus 675, 1113
Yellow Net 1113
Yellow Net = Tobacco Yellow Net Luteovirus 675
Yellow Top 1113
Yellow Top = Strain of Potato Leafroll Luteovirus 675
Tombusvirus 74, 945
Top Rot 489
Topple 436, 875, 1116
Torenia 1113
Torreya 1113
Torula 374
herbarum 962
maculans 374, 1143
Tospovirus 74
Trabutia ficuum 1056
Trabutiella filicina 855
Tradescantia – Zebrina Potyvirus 676
Tradescantia (Wandering Jew, Spiderwort) 1114
Tradescantia zebrina 1114
Tradescantia/Zebrinia Mosaic 811
Trametes 531
hispida 724, 773
hydnoides 805
isabellina 790, 916
mollis 909, 940
pini 478
rigida 903, 1119
sepium 785, 948, 1064
suaveolens 531, 1137
versicolor 517
Trametes spp. 721, 726, 731, 838, 1021, 1068
Tranzschelia 568
cohaesa 716
discolor 568, 711, 716, 724, 793, 1002, 1027
fusca 716
pruni 724
pruni-spinosae 716, 799, 899, 958, 1027
pruni-spinosae var. typica 568
suffusca 716
thalictri 958
tucsonensis 716
viornae 806
Trautvetteria (False Bugbane) 1114
Trechispora 285
alnicola 285, 887
Tree-Poppy (Dendromecon) 1114
Tree-Tomato (Cyphomandra) 1114
Trefoil, Birdsfoot (Lotus) 1114
Trembling fungi 60
Triadimefon 25
Triadimenol 25
Triazophos 28
Trichaptum abietinum 517
Trichocomaceae 53

Trichoderma 531
harzianum 25, 531, 721
viride 531, 960, 975, 1004
Trichoderma sp. 1079
Trichoderma spp. 1102
Trichodorus
christiei 736, 744, 749, 767, 1003, 1087, 1093
obtusus 410
primitivus 410, 738, 963
Trichodorus and Paratrichodorus 409
Trichodorus sp. 760, 791, 1008
Trichodorus spp. 1053
Trichodothis comata 948
Trichothecium 266, 532
roseum 266, 532, 782, 855, 859, 960, 976, 1001, 1006, 1008, 1027, 1035, 1052, 1087, 1112
viride 804
Trichothyriaceae 54
Trichovirus 74
Tricothecium roseum 721, 787
Tricyclazole 25
Tridemorph 25
Trifloxystrobin 25
Triflumizole 25
Triforine 25
Trillium (Wake-Robin) 1114
Triphenyltin Hydroxide 25
Triphragmium 568
ulmariae 568, 958
Tritonia
Mosaic 676
Tritonia (Montbretia) 1115
Trollius (Globeflower) 1115
Tropical Soda Apple (Solanum viarum) 1115
Trumpetvine
Leaf Blight 165
Trumpetvine, Trumpet-Creeper (Campsis) 1115
Trunk Canker 226, 252
Tryblidiella 216
rufula 216, 803
Tsw-Impatiens Serotype 1098
Tubackia (Pirostoma) 352
Tubakia dryina 303, 336, 352, 777, 784, 1025
Tuber Rot 107, 483
Tuberaceae 57
Tubercularia 266
nigricans 967
ulmea 266, 842, 906
Tubercularia sp. 948
Tuberose (Polianthes) 1116
Tuburcinia
clintoniae 1095
trientalis 1089
trienthalus 587
Tulare
Apple Mosaic 722
Apple Mosaic Ilarvirus 604, 676
Tulip
(Tulipa) 1116
Anthracnose 90
Basal Rot 481
Breaking 1116
Breaking Mosaic 938
Breaking Potyvirus 676
Fire 161
Tulip-Tree
Leaf Spot 342
Yellow Poplar (Liriodendron) 1117
Tung Tree (Aleurites) 1118
Tupelo
Leaf Spot 342, 352
Sour Gum, Black Gum (Nyssa) 1118
Tupidanthus 1119
Turnip
(Brassica rapa) 1119
Anthracnose 87
Mosaic 768, 796, 911, 915, 973, 1050, 1058, 1090, 1091, 1120, 1121
Mosaic Potyvirus 676
Mosaic Virus 1000
Turpentine Tree (Syncarpia) 1120

Turtle-Head (Chelone) 1120
Twig
and Branch Canker 233, 267
and Needle Blight 197
Blight 84, 167–170, 176, 179, 182, 183, 186, 188, 195, 197–199, 201, 214, 216, 225, 237, 257, 261, 266, 267, 317, 318, 327, 359, 497
Canker 225, 232, 239–241, 243, 244, 251, 261
Dieback 265, 321
Tylenchorhynchus 410
annulatus 410
brevidus 410, 887
capitatus 410, 1012
claytoni 410, 738, 744, 887, 1003, 1012, 1102
dubius 410, 887
martini 410
maximus 410
Tylenchorhynchus sp. 954
Tylenchorhynchus spp. 1053
Tylenchulidae sp. 399
Tylenchulus 411
semipenetrans 411, 771, 805, 883, 929, 936, 949, 984, 1014
Tylenchus 411
balsamophilus 1097, 1140
marginatus 1084
semipenetrans 803
Tymovirus 75, 1124
Tympanis 266
confusa 266, 1020
Tympanis sp. 756
Typhula 593
Blight 593
idahoensis 593, 888
incarnata 593
itoana 888
variabilis 787
Typhula sp. 783
Udo (Aralia cordata) 1120
Ulocladium 365
cucurbitae 365, 821
Umbravirus 75
Umbrella-Pine (Sciadopitys) 1120
Umbrellawort (Oxybaphus) 1121
Uncinula 452
adunca 454
circinata 452, 731, 759, 954, 1076
clintonii 452, 939, 998
flexuosa 452, 910
geniculata 972
macrospora 452, 845, 892, 908
necator 452, 715, 884, 920, 1128
parvula 453, 892
polychaeta 453, 892
prosopidis 453
prosopodis 962
salicis 453, 1031, 1137
Uncinula sp. 826, 880
Uncinuliella
australiana 453, 818
flexuosa 453
Unicorn-Plant, Proboscis-Flower (Proboscidea) 1121
Uraecium holwayi 898
Uredinopsis 568
arthurii 858
aspera 855
atkinsonii 858
ceratophora 854
copelandii 856
glabra 854
longimucronata 856
longimucronata f. sp. acrostichoides 856
longimucronata f. sp. cyclosora 856
macrosperma 855
mirabilis 857, 861
osmundae 568, 856, 861
phegopteridis 569, 858, 861
pteridis 569
struthiopteridis 569, 856, 861
virginiana 855

Uredo 569
arida 761
artocarpi 569, 730
behnickiana 987
cephalanthi 767
coccolobae 569, 808
contraria 772
epidendri 987
ericae 569
floridana 961
fuchsiae 866
goodyerae 988
guacae 987
guaunabensis 1134
hameliae 893
ignava 740
laeticolor 969
nigropuncta 987
phoradendri 569, 965
sapotae 567
sphacelicola 1081
uviferae 808
Uredo sp. 964
Urocystis 587
agropyri 588, 888
anemones 588, 716, 899, 1045, 1057, 1114, 1115
carcinodes 588, 740, 806, 967
cepulae 798, 986, 1069
colchici 588, 736, 775, 986, 1076, 1077
erythronii 849
flowersii 1143
gladiolicola 588, 876
hypoxis 1089
kmetiana 588, 995, 1125
lithophragmae 901, 941
magica 588
sorosporioides 716, 811, 829, 958, 967
trientalus 587
trillii 1115
tritici 588
violae 1128
waldsteiniae 742
Urocystis waldsteiniae 873
Uromyces 569
acuminatus 943
acuminatus var. magnatus 950, 1076, 1077, 1121
acuminatus var. polemonii 810, 1017, 1030
acuminatus var. steironematis 835
affinis 1089
amoenus 715
andropogonis 995, 1128
apiosporus 1038
appendiculatus 569
appendiculatus var. appendiculatus 570, 745
ari-triphylli 570, 728, 921
armeriae 727
asclepiadis 730, 766, 1127
aureus 798
betae 570, 749, 1104
bidenticola 751
brodiaeae 762
ciceris-arietini 570, 795
claytoniae 806
colutea 755
commelinae 1114
compactus 735, 758
costaricensis 570, 740
dactylidis 888, 1045
dianthi 570, 780, 833, 1103
euphorbiae 1029, 1075, 1085
fabae 570, 999
galii-californici 570, 868
genistae-tinctoriae 870
gentianae 870
geranii 872
graminicola 1091
halstedii 1115
hedysari-obscuri 1103
heterodermus 849
holwayi 938
hordeinus 979

houstoniatus 757, 912
hyalinus 1077
inaequialtus 1063
indigoferae 916
jonesii 1045
junci 727, 729, 735, 802, 848, 890, 1097, 1107
limonii 1090
lupini 945
lycoctoni 967
miurae 866
mysticus 888
necopinus 1089
oblongisporus 1059
occidentalis 945
peckianus 912
perigynius 879, 880, 1047, 1056
phaseoli 745, 746
phaseoli var. typica 745
plumbarius 870, 982
primaverilis 979
Probus 757
punctatus 570, 735
rudbeckiae 879, 1056
ruelliae 1057
scirpi 783
shearianus 1062
silenes 1070
silphii 1071, 1097
solidaginis 880
sparganii 1099
speciosus 811
striatus 959
suksdorfii 946, 1070
transversalis 876
trifolii 570
triquetrus 1060
unitus 935
verruculosus 946
zygadeni 1143
Uromyces sp. 570, 1114
Urophlyctis
pluriannulata 1103, 1144
pulposa 1061
Uropyxis 570
amorphae 714, 917
daleae var. eysenhardtiae 570
eysenhardtiae 570
petalostemonis 1014
Ustilaginaceae 59
Ustilaginoidea virens 814, 1051
Ustilago 589
avenae 589
buchloes 589, 888
bullata 589
claytoniae 967
coicis 923
cynodontis 888
esculenta 589, 1136
gayophyti 891
heufleri 589, 849
hordei 589
kolleri 589
maydis 589, 814
mulfordiana 591
oxalidis 989
penniseti 1009
shiraiana 740
speculariae 1080
striiformis 591, 888
tritici 591
vaillantii 885, 1066
vinosa 972
violacea 591, 946, 1063, 1070
Ustulina 532
deusta 532, 748, 904
vulgaris 845, 939, 954
Uvularia (Bellwort, Merry-Bells) 1121

Valerian
Garden Heliotrope (Valeriana) 1121
Red, Jupiters-Beard (Centranthus) 1122
Valerianella (Corn-Salad or Lamb's Lettuce) 1122
Valsa 266, 532
ambiens 998
ambiens subsp. leucostomoides 532

cincta 267, 1000
kunzei 267, 930
leucosomoides 954
leucostoma 267, 723, 792, 816, 969, 976, 1000, 1004, 1041
nivea 1031, 1137
salicina 267, 988, 1137
sordida 267, 1137
Valsa kunzei 861
Valsa leucostoma 1026
Valsa spp. 1137
Valsaceae 56
Vancouveria 1122
Vanda Ring Spot 987
Vanilla 1122
Vanilla-Leaf (Achlys) 1122
Varicosavirus 75
Variegation 436, 744, 760, 829, 1025, 1039, 1093
Vein Mosaic 1000
Velvet Bean (Stizolobium) 1122
Venturia 576
acerina 954
arctostaphyli 715, 790, 869, 1139
cerasi 576, 723
chlorospora 573
circinans 872
compacta 817
crataegi 895
dickei 940
inaequalis 576, 722, 817, 895, 970, color plate 12
orbicula 980
pirina 1041
populina 1030
pyrina 578, 1006
rhododendri 1049
tremulae 1030
Venturia sp. 815
Venus'S Flytrap (Dionaea muscipula) 1123
Veratrum (False-Hellebore) 1123
Verbascum 1123
Verbena (Native Species) 1123
Verbena (Nemisia diascia) 1124
Verbena, Garden (Verbena hortensis) 1123
Verbesina (Crownbeard) 1124
Vermicularia 267
capsici 921
coptina 881
ipomoearum 267, 968
podophylli 958
polytricha 921
sparsipila 1032
Veronica (Speedwell) 1124
Verrucosis 597
Verticicladiella
abietina 533, 1021
penicillata 533, 1021
procera 1021
wagenerii 838, 861, 1021
Verticillium 693
albo-atrum 693, 704, 709, 711, 722, 724–726, 731, 735–737, 741, 749, 750, 754, 760, 771, 773, 776, 781, 785, 786, 788, 789, 794, 795, 797, 801, 802, 805, 812, 822, 827, 830, 833, 842, 843, 845, 848, 849, 865, 867, 871, 875, 898, 906, 908, 910, 911, 915, 923, 931, 936, 940, 942, 949, 952, 955, 956, 961, 962, 967, 983, 984, 1002, 1010, 1012, 1014, 1015, 1017, 1024, 1025, 1027, 1030, 1032, 1033, 1036, 1046, 1047, 1054, 1057, 1058, 1061, 1067, 1068, 1073, 1074, 1087, 1091, 1094–1096, 1098, 1102, 1113, 1120, 1126, 1127, 1134, 1142
albo-atrum f. sp. menthae 964
buxi 760
dahliae 697, 704, 707, 709, 717, 729, 731, 768, 802, 840, 890, 911, 915, 935, 956, 1011, 1034, 1047, 1091, 1098, 1121
fungicola 697, 973, 990
Wilt 693

Verticillium sp. 734, 756, 809, 823, 836, 842, 879, 903, 988, 1004, 1047, 1082, 1101
Vesiculomyces citrinus 471
Vetch (Vicia) 1125
Viburnum 1125
  Downy Mildew 281
Vidalia Sweet Onion (Allium) 1126
Vinca (Periwinkle, Ground-Myrtle) 1126
Vincetoxicum (Milkvine) 1127
Vinclozolin 25
Violet
  (Viola odorata and Native Species) 1127
  Root Rot 489, 521
  Scab 601
Vipers-Bugloss (Echium) 1128
Virescence 133, 1042
Virgella robusta 378
Virginia
  Creeper (Parthenocissus quinquefolia) 1128
  Creeper Soft Anthracnose 598
Virginia Crab Stem Pitting and Brownline 1006
Virocides 11
Viroids 75
Virus Complex 884
Virus epidemic 933
Viruses 68, 1163
Viscum (True Mistletoe) 369
Viscum album 370, 709, 720, 731, 752, 817, 845, 895, 902, 910, 942, 954, 970, 1005, 1014, 1027, 1031, 1040, 1137
Vitex (Chaste-Tree) 1129
Volutella 216, 267
  albido-pila 987
  Blight 267
  buxi 217, 267, 760
  dianthi 1103
  diaphana 878
  mellea 994
  pachysandrae 217, 990
  phlogina 1016
  vanillae 1122
  vincae 1126
Volutella sp. 829, 921

Wahlenbergia (Southern Rockbell) 1129
Waikavirus 75
Wallflower
  (Cheiranthus) 1129
  Western (Erysimum) 1129
Walnut
  Anthracnose 95
  Blight 126, 129
  Brooming Disease 677
  Canker 250
  Meadow Nematode 406
  Ring Spot 307
  Toxicity 1049
  Wilt 1111
Walnut (Juglans) (Includes Butternut, Black, English, and Japanese Walnuts) 1130
Water Deficiency 436
Water Shield (Brasenia) 1134
Water-Core 720
Water-Cress (Nasturtium officinale) 1131
Water-Elm (Planera) 1132
Water-Horehound (Lycopus) 1132
Water-Hyacinths (Eichhornia) 1132
Water-Lily (Nymphaea) 1132
Water-Lily, Yellow Pondlily (Nuphar) 1132
Water-Primrose (Jussiaea) 1134
Watermelon
  (Citrullus) 1133
  Curly Mottle 1134
  Curly Mottle Bigeminivirus 677
  Leaf Spot 360
  Mosaic 960, 961, 1087, 1121, 1134
  Mosaic Potyvirus 677
  Silver Mottle Tospovirus 677

Stunt 1134
Wilt 690
Watery Fruit Rot 500
Watery Leak 519
Watery Soft Rot 526
Watsonia 1134
Wax-Myrtle, Candleberry (Myrica cerifera) 1134
Web Blight 167, 192, 194, 522
Web Blotch 221
Weed-Killer Injury 436, 1053
Weigela 1135
West
African Spiral Nematode 408
Western Aster Yellows 757, 761
Western Aster Yellows Phytoplasma 1132
Western Cucumber Mosaic 995
Western Dwarf Mistletoe 370
Western Gall Rust 540, 541, 544, 545
Western Maple Leaf Blister 295
Western X-Disease 799
Western Yellow Blight 1112
Western Yellow Rust 557
Wet Scale Rot 527
Wetwood 109, 1118
Wheat
Nematode 386
Streak Mosaic 814, 1136
Streak Mosaic Rymovirus 677
Wheat (Triticum) 1135
Whetzelinia sclerotiorum 706, 850, 1072
Whip-tail 768
Whipplea 1135
Whiskers, Leak 523
White
Blight 374
Blister 679
Break 876
Butt Rot 471
Clover Mosaic 808
Clover Mosaic Potexvirus 677
Flaky Sapwood Rot 514
Heart Rot 490, 532
Leaf Spot 354
Line Mosaic 678
Mold 339, 374
Mold Rot 526
Mottle Rot 485
Mottled Heart Rot 517
Mottled Rot 477–479
Mottled Wound Rot 473
Pine Blister Rust 541
Pocket Rot 515–517
Root Rot 471, 515, 524
Rot 470, 472, 518, 527
Rust 563, 679, 680
Sapwood Rot 469, 515, 516
Seed 1118
Smut 584
Spongy Heart Rot 515, 516
Spongy Rot 477–479, 528
Spot 310, 314
Streak 975
Tip Blight 211
Trunk Rot 478
Wood Rot 531
Whortleberry, Bilberry (Vaccinium spp.) 1135
Wild
Cucumber Mosaic 955
Cucumber Mosaic Tymovirus 678
Garlic (Allium vineale); Wild Mustard (Brassica kaber) 1136
Rice (Zizania) 1136
Wildrye (Elymus) 1136
Willow
Black Canker 258, 259
Leaf Spot 321
Powdery Mildew 453, 454
Scab 573
Willow (Salix) (Includes Weeping Willow, Pussy Willow) 1136
Wilt 108, 122, 243, 262, 265, 457, 468, 483, 484, 512, 526, 527, 687–689, 691–693, 804, 1063
Wind Scab 1027

Wind Whip 744
Wineberry Latent 754
Wineberry Latent Virus 678
Winged Bean (Psophocarpus tetragonolobus) 1138
Winter Blight 168, 169
Winter Cress (Barbarea) 1138
Winter Injury 438, 920
Winterberry (Ilex verticillata) 1138
Wintergreen, Checkerberry (Gaultheria procumbens) 1138
Wintergreen, Waxflower 1139
Wire-stem 303
Wisconsin Pea Streak 1000
Wisteria
  Leaf Spot 351
  Mosaic 678
  Vein Mosaic 1139
  Vein Mosaic Potyvirus 678
Wisteria (Wistaria) 1139
Witch-Hazel (Hamamelis) 1139
  Leaf Spot 350
Witches' Broom 130, 133, 139, 290, 339, 377, 549, 937, 942, 1010, 1113
Witches' Broom Disease 836
Witches' Broom Rust 548, 551
Withertip 87, 90–92
Wolfberry (Symphoricarpos occidentalis) 1139
Wolfiporia cocos 518, 930
Wood Rose (Rosa gymnocarpa, R. californica) 1140
Wood Rot 474, 491, 514, 529
Wood-Betony, Lousewort (Pedicularis) 1140
Woodrush (Luzula) 1140
Wound Rot 461, 524
Wyethia 1140

Xanthomonas 122
  albilineans 122
  axonopodis 122, 707, 985
  barbareae 1138
  begoniae 122, 750
  campestris 122, 123, 709, 725, 729, 733, 736, 752, 767, 785, 796, 913, 931, 985, 1042, 1044, 1081, 1105, 1119
  campestris pv. armoraciae 767, 911, 1043
  campestris pv. asclepiadis 123, 766
  campestris pv. barbareae 123
  campestris pv. begoniae 123
  campestris pv. campestris 864
  campestris pv. carotae 123, 813
  campestris pv. citri 123, 803
  campestris pv. corylina 124
  campestris pv. cucurbitae 124
  campestris pv. cyamopsidis 124, 891
  campestris pv. dieffenbachiae 124, 718, 809
  campestris pv. fici 756
  campestris pv. fragariae 124
  campestris pv. glycines 124
  campestris pv. gummisudans 125
  campestris pv. hederae 125
  campestris pv. hyacinthi 125
  campestris pv. incanae 125
  campestris pv. juglandis 126
  campestris pv. malvacearum 126, 901
  campestris pv. maniotis 756
  campestris pv. oryzae 126
  campestris pv. papavericola 126
  campestris pv. pelargonii 126, 127
  campestris pv. phaseoli 127
  campestris pv. pruni 127
  campestris pv. raphani 128
  campestris pv. vesicatoria 128
  campestris pv. vignicola 128
  campestris pv. vitians 128, 933, 1110
  campestris pv. zinniae 128, 1144
  campestris var. fragariae 1092
  carotae 128, 782
  compestris 973

corylina 128, 895
cucurbitae 129, 821, 1086
dieffenbachiae 129, 796, 1105
fragariae 1092
geranii 872
glycines 129, 1078
gummisudans 129, 875
hederae 129, 920
hyacinthi 129, 913
incanae 129, 1091
juglandis 129, 1130
maculifolium-gardeniae 868
nigromaculans 130
nigromaculans f. sp. zinniae 1144
oryzae 129, 780
papavericola 129, 773, 1032
pelargonii 129, 871
phaseoli 129, 743, 746, 911
poinsetriaecola 1029
pruni 129, 711, 712, 723, 791, 793, 794, 798, 976, 1000, 1026
ricinicola 784
solanacearum 901
translucens pv. cerealis 885
translucens pv. poae 885
translucens pv. undulosa 733
vesicatoria 130, 1011, 1110
vesicatoria pv. raphani 1043, 1119
vesicatoria var. raphani 130
vignicola 130
vitians 130, 934, 1011, 1105
Xanthomonas sp. 883
Xanthosma 1140
Xenodochus
carbonarius 765, 1063
minor 765, 1063
Xerophyllum (Turkeybeard) 1141
Xiphinema 411
americanum 411, 731, 736, 756, 760, 836, 845, 871, 887, 981, 1001, 1008, 1020, 1031, 1052, 1084, 1093, 1111, 1126
bakeri 412, 1068
chambersi 412, 1093
diversicaudatum 412, 1052, 1093
index 412, 715, 859, 883, 920, 967, 1024
krugi 1052
pacificum 1001
radicicola 412
Xiphinema sp. 723, 954
Xylaria 533
apiculata 1035
digitata 895
hypoxylon 533, 881, 895
longeana 874
mali 533, 721, 907, 1006
multiplex 843
polymorpha 533, 893
Xylaria sp. 1006, 1046
Xylaria spp. 793, 845
Xylariaceae 56
Xylella fastidiosa 130, 844, 953, 972, 980, 983, 1007, 1099
Xylem limited Rickettsialike 1025
Xylem limiting bacteria 972

Yam
Cinnamon-Vine (Dioscorea) 1141
Nematode 409
Yarrow (Achillea) 1141
Yaupon (Ilex vomitoria) 1141
Yeast Spot 498
Yellow 297
Bean Mosaic 876
Flaky Heart Rot 477, 479
Gum Disease 101, 103
Leaf Blister 297
Leaf Rust 560, 564
Leaf Spot 289, 738
Mottle 983
Mottle Begomovirus 678
Net 1104
Rust 552
Spotting 780
Strapleaf 800
Witches' Broom Rust 554
Yellow-Root (Xanthorhiza) 1141

Yellowing 133, 1079
Yellows 133, 438, 482, 687, 689, 851, 1064, 1082, 1090
Yellowwood (Cladastris) 1141
Yerba Buena (Micromeria) 1142
Yerba Santa (Eriodictyon) 1142
Yew (Taxus) 1142
Yucca
  Leaf Blight 184
  Leaf Spot 344
Yucca (Adams-Needle, Joshua-Tree, Spanish Bayonet) 1142

Zamia (Coontie) 1143
Zauschneria (Fire-Chalice, California Fuchsia) 1143
Zebra
  Plant (Aphelandra) 1143
Zephyranthes (Atamasco-Lily, Zephyr-Lily) 1143
Zigadenus 1143
Zimmerman's Spiral Nematode 394
Zinc Deficiency 438
Zineb 25
Zinnia 1144
  Blight 153
Ziram 25
Zizia (Meadow Parsnip) 1144
Zonate Leaf Spot 180, 306, 320, 331, 332
Zonate Ring Spot 755, 807
Zoysia
  Spine Nematode 390
Zoysia (Japanese Lawn Grass) 1145
Zucchini
  Yellow Mosaic 822, 960, 1087, 1134
  Yellow Mosaic Potyvirus 678
Zygocactus
  Montana X 799
  Montana X Potexvirus 678
Zygomycota 50
Zygophiala 222, 286
  jamaicensis 222, 286, 780, 1028

Plate 1 **a** Lethal Yellowing on Coconut Palm caused by a Phytoplasma Pathogen. **b**, **c** Tulip Break on Tulip caused by Lily Latent Mosaic Virus. **d**, **e** Ringspot on Vanda Orchid caused by Vanda Ringspot Virus

a

b

c

Plate 2 **a**, **b** Rust on Rose caused by **Phragmidium mucronatum**. **c** Cedar-Apple Rust on Apple caused by **Gymnosporangium juniperi-virginianae**

Plate 3 **a** Cedar-Apple Rust on Cedar caused by **Gymnosporangium juniperi**. **b** Stunt on Chrysanthemum caused by Chrysanthemum Stunt Viroid. Var. Dark Pink Orchid Queen

Plate 4 **a** Green Flowers on Chrysanthemum caused by Aster Yellows Phytoplasma. **b** Phyllody on Hydrangea caused by a Phytoplasma Pathogen

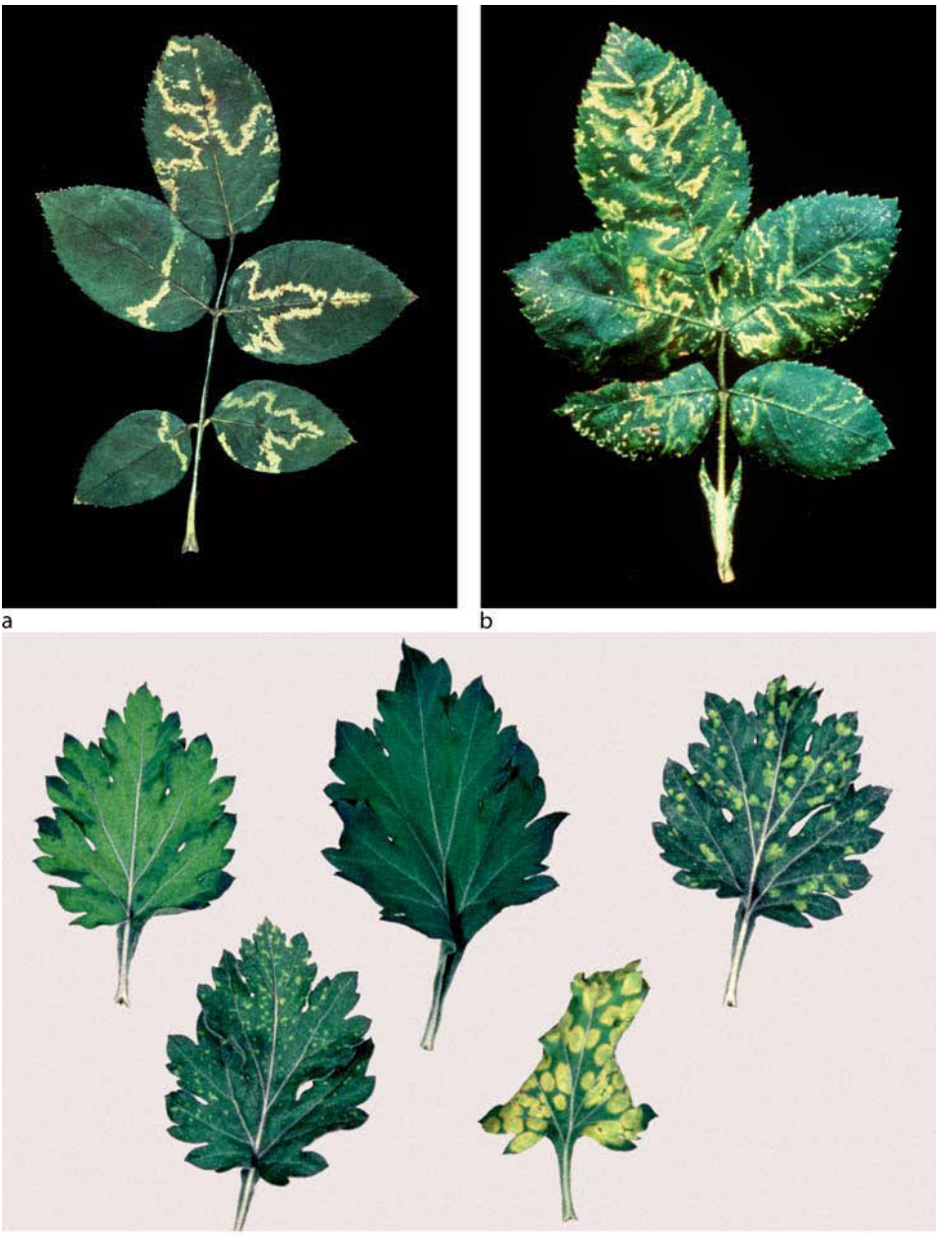

Plate 5 **a**, **b** Mosaic on Rose caused by Prunus Necrotic Ringspot Virus. **c** Foliar Symptoms on Chrysanthemum (Variety Bonnie Jean) caused by (clockwise from upper left) Chrysanthemum Chlorotic Mottle Viroid, Healthy Leaf, Potato Spindle Tuber Viroid, Chrysanthemum Stunt Viroid, and Potato Spindle Tuber Viroid (Mild Strain)

Plate 6 **a** Bacterial Leaf Rot on Dieffenbachia caused by **Erwinia chrysanthemi**. **b** Bacterial Leaf Rot on Philodendron caused by **Erwinia chrysanthemi**

Plate 7 **a** Common Leafspot on Boston Ivy caused by **Guignardia bidwellii**. **b** Crown Gall on Chrysanthemum caused by **Agrobacterium tumefaciens**

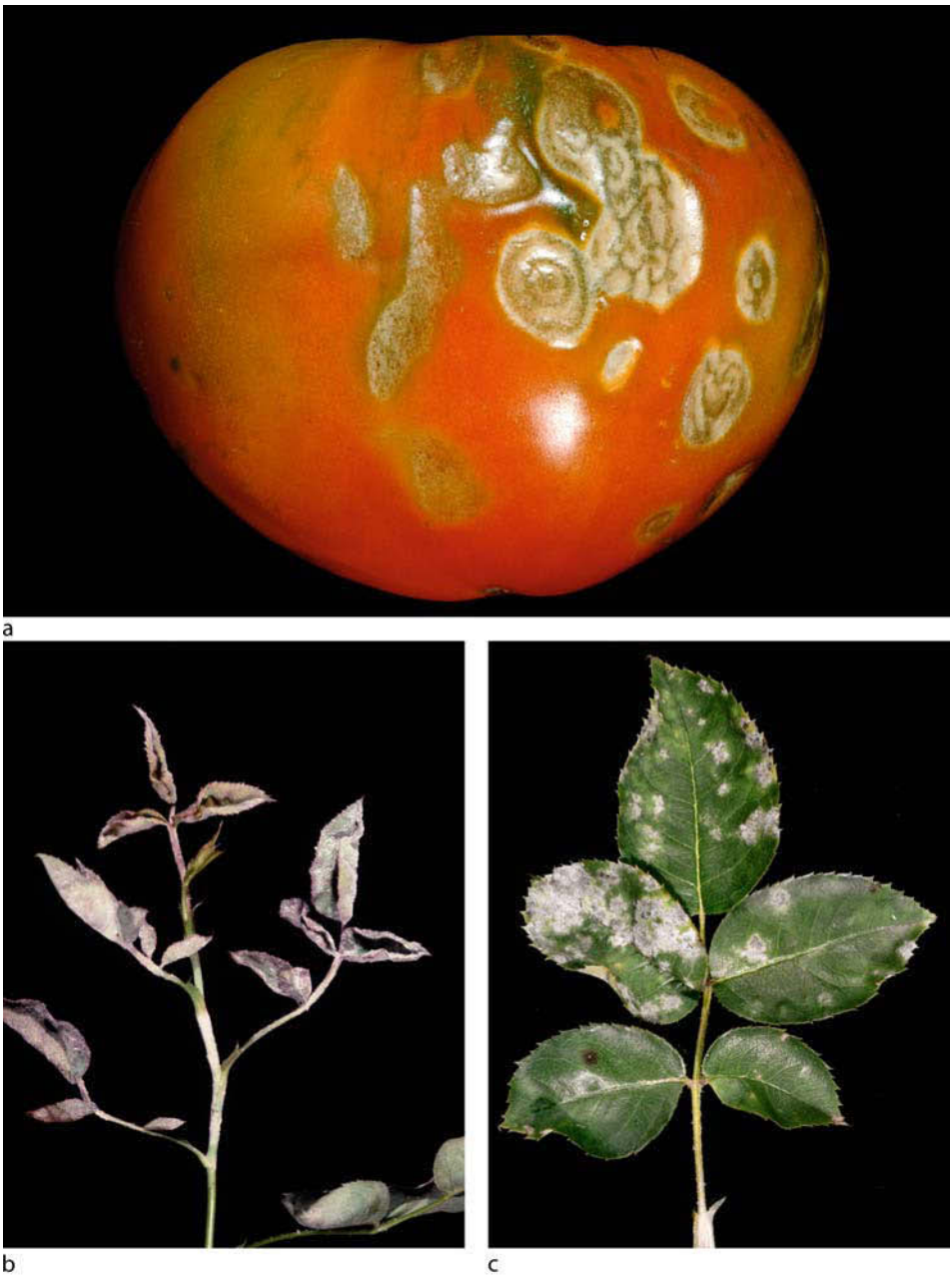

Plate 8 **a** Ringspot on Tomato Fruit caused by Cucumber Mosaic Virus. **b**, **c** Powdery Mildew on Rose caused by **Podosphaera pannosa**

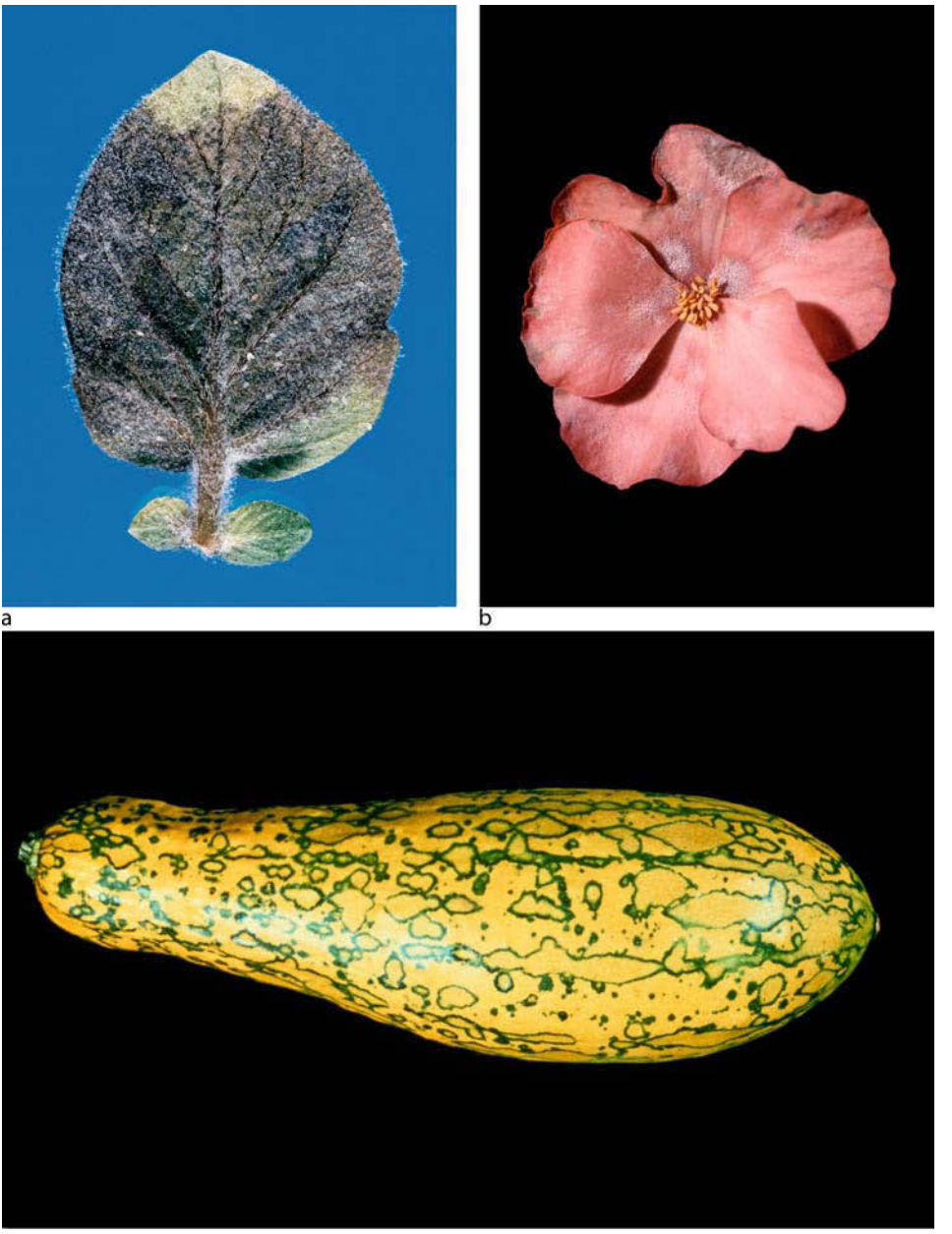

Plate 9 **a** Late Blight on Potato caused by **Phytophthora infestans**. **b** Powdery Mildew on Begonia caused by **Erysiphe cichoracearum**. **c** Mosaic on Squash caused by Cucumber Mosaic Virus

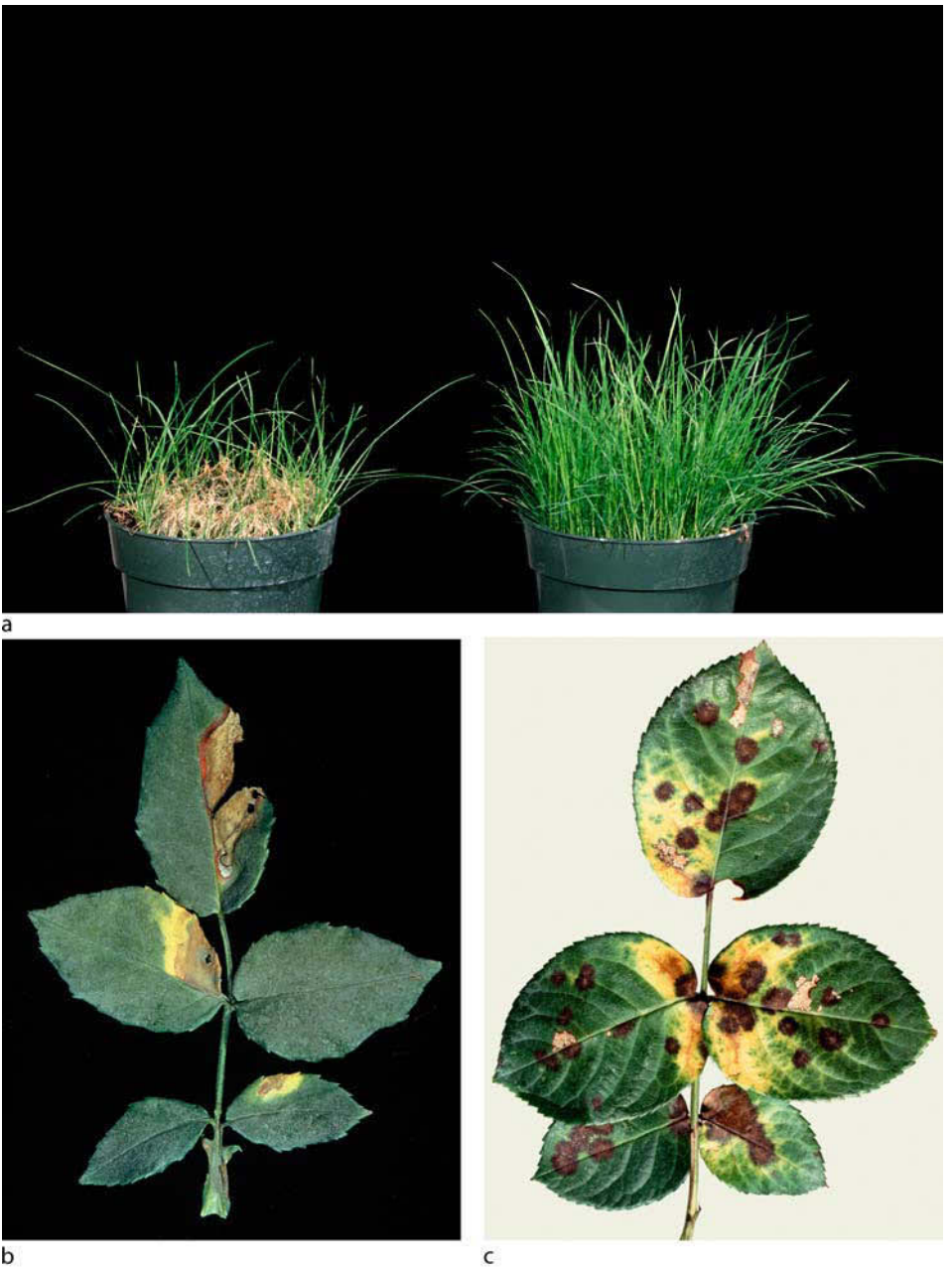

Plate 10 **a** Dollar Spot on Turf caused by **Sclerotinia homeocarpa**. **b** Copper Injury on Rose caused by sprays containing Copper. **c** Blackspot on Rose caused by **Diplocarpon rosae**

Plate 11 Foliar Nematode on Chrysanthemum caused by **Aphelenchoides ritzemabosi**

Plate 12 **a** Foliar Nematode on Chrysanthemum caused by **Aphelenchoides ritzemabosi**. **b** Apple Scab on Apple caused by **Venturia inaequalis**

Plate 13 **a**, **b**, **c**, **d** Rust on Jack-in-the-Pulpit caused by **Uromyces caladii**

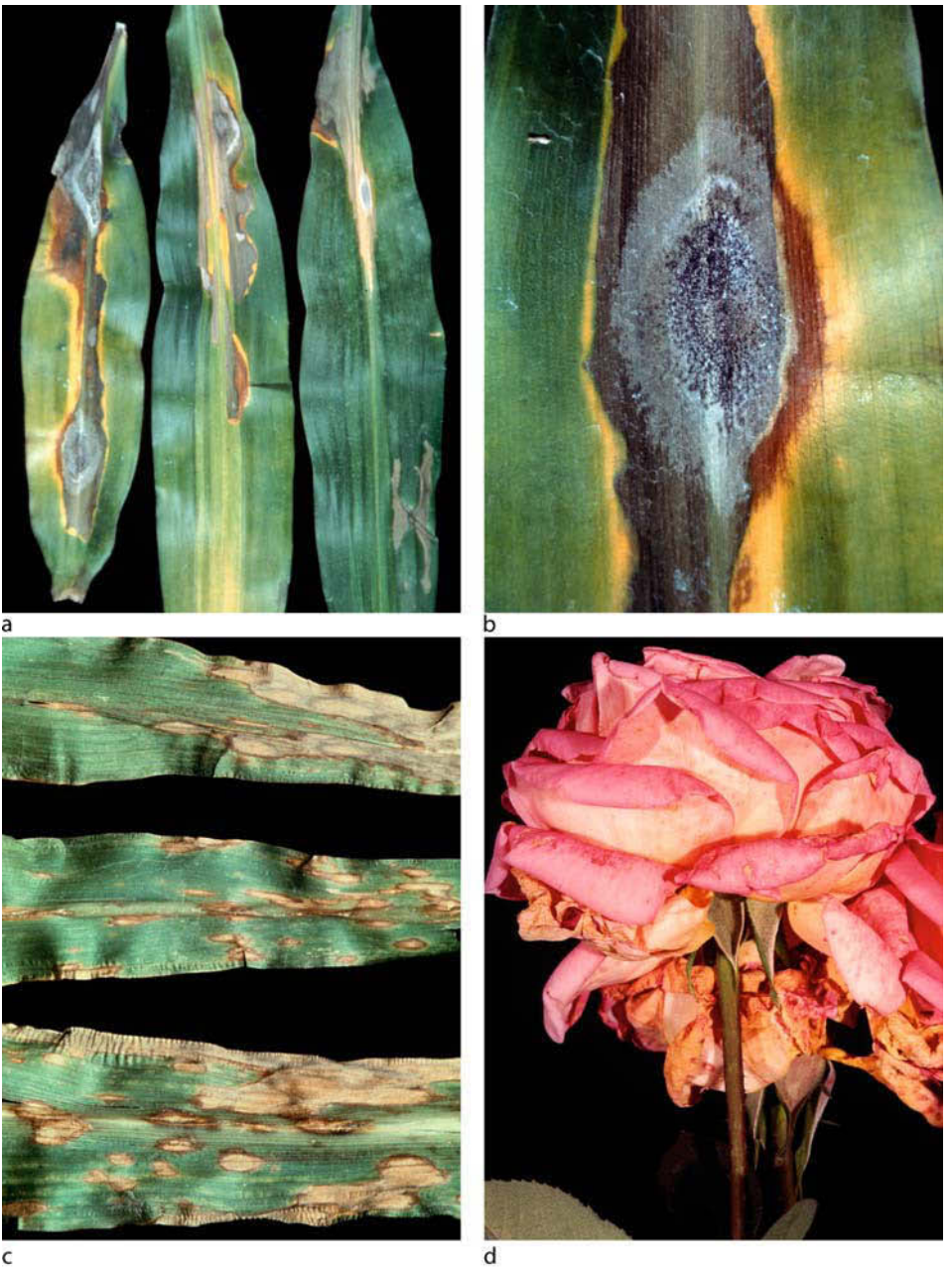

Plate 14 **a**, **b** Leaf Spot on Dracaena caused by **Physalospora dracaenae**. **c** Yellow Leaf Blight on Corn caused by **Phyllosticta maydis**. **d** Blossom Blight on Rose caused by **Botrytis cinerea**

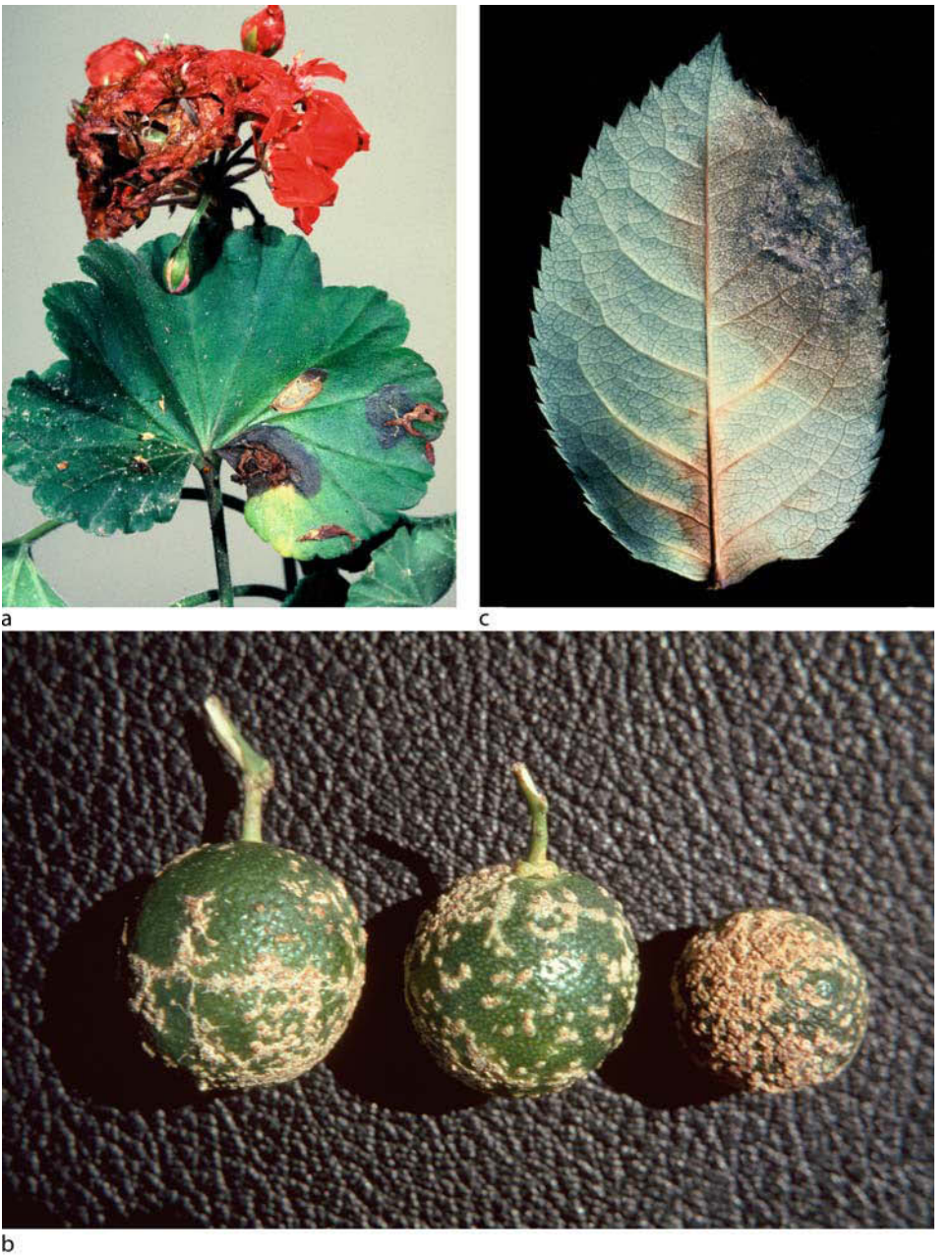

Plate 15 **a** Flower and Leaf Blight on Geranium caused by **Botrytis cinerea**. **b** Scab on Citrus caused by **Elsinoë fawcettii**. **c** Downy Mildew on Rose by **Peronospora sparsa**

a

b

Plate 16 **a** Brown Rot on Cherry caused by **Monilinia fructicola**. **b** Downy Mildew on Rose by **Peronospora sparsa**